SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH 1909.

GENERAL PHYSICS.

357. *Mirror Derivator.* **A. Wagener.** (Phys. Zeitschr. 10. pp. 57–59, Jan. 15, 1909.)—Reusch has used a plane mirror applied transversely to a curve to indicate the direction of the normal when there is no kink at the point of junction of the curve and its reflection. In the author's instrument a vertical spindle carries a mirror at its lower extremity, whose plane is in the plane of the axis of the spindle. The spindle also carries a graduated disc, and its bearing carries pointed feet. A system of parallel lines is drawn, cutting the curve which is being studied. Two of the feet of the instrument lie in the plane of the axis of the spindle, and they are placed on one of the lines. The setting of the mirror then gives the direction of the curve at the point of intersection of the straight line and curve with respect to the system of straight lines. A point depending from the disc may then be pressed into the paper, giving another point on the tangent. The disc may now be turned through 90°, carrying this point, which will then give a point on the normal. Tests show that the errors in the angles indicated by the instrument do not exceed 0·4°. F. R.

358. *Standard Clock Rates.* **W. S. Eichelberger.** (Science, 28. pp. 846–848, Dec. 11, 1908. Abstract of paper read before the Astron. and Astrophys. Soc. of America.)—Discussion of the rates of the standard clock Riefler 70 of the U.S. Naval Observatory at Washington. The clock is kept in a vacuum case in a vault with artificially controlled temperature, and the performance is so good that by means of a formula deduced from a least-square solution of the observed daily rates it has been found possible to predict the corrections to within 0·03 sec. C. P. B.

359. *Method of detecting Bending of Columns.* **C. A. M. Smith.** (Inst. Mech. Engin., Proc. 3. pp. 697–709; Discussion, pp. 710–715, July, 1908. Engineering, 86. pp. 253–255, Aug. 21, 1908.)—The author's instrument, called the "sphingometer," has two heads, one clamped to each end of the test-piece by three set-screws 120° apart. Any extension, compression, or bending of the test-piece causes a lengthening or shortening of three springs placed between the heads, each consisting of a flat strip spirally wound in opposite directions starting from its centre. The lengthening or shortening is accompanied by a rotation of the centre with respect to the ends, and the amounts of the rotations are read upon a scale on which a beam of light is reflected from mirrors carried at the centres of the springs. The indications are calibrated by micrometer attached to each of the three elements. As used each scale division corresponded to a strain of about 0·0000254 in. of the specimen. Examples are given showing the results of tensile and compression tests, and in both cases the strains measured by the three elements differ much from one another, but their averages give normal values of the modulus. F. R.

360. *New Apparatus for Kite Work.* **F. H. Field.** (Meteorolog. Zeitschr. 25. pp. 491–496, Nov., 1908.)—The large diurnal variation of temperature in India renders impossible the determination of the vertical temperature gradient from kite ascents extending over, say, 4 or 5 hours. To get over this difficulty the meteorograph is attached, not to the kite, but to a special carrier which slides along the kite wire. A sail attached to the carrier supplies the power for raising the latter along the wire. On coming in contact with the kite the sail is automatically liberated, and the carrier slips back along the wire and returns to the operator. The whole apparatus weighs about 0·7 kg., of which 120 gm. falls to the portion of the meteorograph. The meteorograph is a development of the Dines kite meteorograph. The chief improvement consists in tracing the records of temperature, pressure, and humidity on a silvered glass disc with "pens" consisting of points of hardened steel. The traces thus obtained are about 0·05 mm. in thickness, and can be read easily under a microscope. Successful use has been made of the apparatus in the Arabian Sea, where soundings of the atmosphere up to heights of about 1·2 km. were obtained in about 15 min. R. G. K. L.

361. *Determination of Elastic Limit by a Thermoelectric Method.* **A. N. Dinnik.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. No. 8. pp. 335–339, 1908.)—The elastic elongation of metallic rods is accompanied by heating of the rods proportional to the tensile stress. When the elastic limit is exceeded a sudden rise of temperature occurs. The author makes use of this sudden heating, indicated by means of a Fe-Cu thermoelectric couple and a d'Arsonval galvanometer registering 10^{-10} amp., for the measurement of the elastic limit. T. H. P.

362. *Optical Method of estimating Hardness. Application to Iron Sulphides.* **Ziegler.** (Soc. d'Encouragement, Rev. de Métallurgie, 5. pp. 565–570, Sept., 1908. Metallurgie, 5. pp. 715–717, Dec. 8, 1908. Abstract.)—The relative hardness of constituents of alloys and other metallographic preparations can be estimated by polishing in relief and measuring the differences of level to 0·001 mm. by means of a fine micrometer-screw focussing adjustment on the microscope. In the case of a sample of iron wire heated many hours in boiling sulphur, the following levels were measured by this means: S, 0; FeS_2, +25; FeS, +17; Fe, +12·5, in microns. The Mohs' scale numbers were 2·5, 6·0, 4·7, 3·5 respectively. Incidentally it was established that FeS is formed before FeS_2, and that the impurities of the iron tend to collect at its centre. The method is also applicable in comparing the rates of etching of constituents, *e.g.*, in samples similar to the above, polished with practically no relief, and etched in picric acid, the level of the FeS was from 5 to 7 microns above that of the iron. F. R.

363. *Hardness Testing.* **E. Meyer.** (Zeitschr. Vereines Deutsch. Ing. 52. pp. 2077–2078, Dec. 26, 1908.)—In the paper referred to in Abstract No. 1868 (1908) the author mentions that the values of P/t^2 in the conical punch test decrease markedly with increasing load P; t being the depth of impression measured with respect to the unloaded position of the punch. If, however, t be corrected by adding on t_1 equal to the amount of rounding off of the point of the punch, t_2 equal to the depth of impression made by the punch due to its own weight, and h equal to the height to which the metal flows up round the punch with respect to the general surface of the test specimen, then it is found that $P/(t + t_1 + t_2 + h)^2$ is constant for a long range of loading. Further, h is found to be proportional to the diam. of impression for the same range. Hence P/t'^2 is constant for the same range of loading, where t' is the depth of the apex of the geometrical cone below the general surface. F. R.

364. *Breakdown of Materials under Combined Stresses.* **L. B. Turner.** (Engineering, 87. pp. 169–170, Feb. 5, and pp. 203–205, Feb. 12, 1909.)—Guest's results [see Abstract No. 1400 (1908)] are criticised on the ground that the same specimen was used for a number of tests, so that the result of each is partially vitiated by those that have preceded it. The results undoubtedly show, however, that the max. shear stress theory is much nearer the truth than either the max. tension or max. strain theories. The author gives results of tests of annealed steel tubes under tension, or torsion, or combined internal hydrostatic pressure and longitudinal tension. With the exception of distinctly abnormal results, the max. shear stress at the elastic limit in simple tension and simple torsion was constant, with a mean discrepancy of about 8 per cent. The results differ from those demanded by the max. tension theory by about 50 per cent., and from the max. strain demands by about 35 per cent., if Poisson's ratio be taken as 0·8. With internal hydrostatic pressure and longitudinal tension the agreement between the max. shear stress at the elastic limit observed by extensometer and that in simple tension was not so close, pairs of values in lbs. per sq. in. being 30,400, 32,500; 27,600, 33,300; 28,000, 32,000 respectively. F. R.

365. *Coefficient of Viscous Traction of Lead-Tin Alloys.* **A. E. Dunstan.** (Phil. Mag. 17. pp. 192–201, Jan., 1909.)—When wires of lead, tin, or lead-tin alloys are stressed beyond the elastic limit, the coefficient of viscous traction remains constant for a given load. The coefficient varies greatly for different loads in alloys containing less than 10 per cent. tin. The relative effect of tin on the mobility of lead is very great; 10 per cent. Sn lowers the arbitrary coefficient from 160 to 37. From 20 to 100 per cent. Sn the coefficient varies little. It is pointed out that the greatest divergence of the coefficient from the mean value occurs in the neighbourhood of the composition 2Pb : 1Sn, which is of interest in connection with the viscosity-concentration laws of viscous liquids. F. R.

366. *Stresses in Dams.* (1) **J. W. Ottley** and **A. W. Brightmore**; (2) **J. S. Wilson** and **W. Gore**; (3) **E. P. Hill.** (Inst. Civ. Engin., Proc. 172. pp. 89–106, 107–133, 134–142; Discussion and Correspondence, pp. 143–217, 1907–1908.)—In the first of these three papers the authors investigated the stresses in dams by means of submitting a model slice made of plasticine to water pressure on the water face. The conclusions are: If a masonry dam be designed on the assumption that the stresses on the base vary

uniformly and are parallel to the resultant force on the base, the actual normal and shearing stresses on both horizontal and vertical planes will, neglecting effects of temperature-change and unequal settlement, be less than those provided for. There cannot be any tension near the outer toe. There will be tension on planes other than horizontal near the inner toe; the max. intensity will generally be equal to the average shear stress on base and its plane of action inclined at about 45°; in the dam, above the base, the max. tension will be about half this amount, and act on a plane less inclined to the horizontal. The existence of the tension was proved by the cracking of the model. It was found that plasticine, notwithstanding its plasticity, will crack quite short under long-continued, though small, tension.

(2) In the second paper, model dam sections made of indiarubber were subjected to a number of loads to simulate water pressure, and the effective specific gravity of the rubber was increased to a suitable extent by weights hung from numerous rods passing through it. Twenty-four hours after loading the model was photographed, and the strains measured upon the photograph from the positions of lines, originally straight, drawn upon the model. The main conclusions are: Although the lines of resistance are well within the middle thirds, tensile stresses are observed in all cases at the inner toe. This could only be avoided by reducing to zero the shearing stress in vertical planes near the inner toe. The stress will be somewhat reduced if the corner be rounded, as, *e.g.*, by cutting a fillet in a large stone. The crack due to tension, if formed, would probably tend to travel nearly vertically downwards, and hence to be comparatively harmless. Tension is not observed in any part of dam or foundations near outer toe, but high compressive stresses are found in all directions except normally and near to the outer face. The shape of the junction between dam and foundations affects greatly the distribution of shear stress in the plane of junction. In the dam above the foundations the max. shear stress is a little less than half the max. principal stress, and is given approximately by $S = T/2\cos^2\phi$, where T is the max. vertical pressure determined by the trapezium law, and ϕ is the angle between resultant and vertical.

(3) The author of the third paper, adopting Unwin's suggestion (Engineering, 79. p. 593, 1905) that the shearing stress at any point may be found by considering the total vertical reactions, between the point and either face, along two horizontal planes at unit distance apart, arrives at the following solution for the vertical force p, the horizontal force p', and shearing force q acting on a unit element of mass:—

$$p = \frac{W}{b}\left(2 - \frac{3d}{b}\right) - \frac{h_1^3}{yb^3} + \left\{\frac{6W}{b}\left(\frac{2d}{b} - 1\right) + \frac{2h_1^3}{yb^2}\right\}\frac{x}{b}.$$

$$p' = \frac{h_1}{y} + \left\{\frac{2Wm^2}{b^3}\left(2 - \frac{9d}{b}\right) - \frac{3h_1(b - mh_1)^2}{yb^4} + \frac{m}{b}\right\}x^2$$

$$+ \left\{\frac{6Wm^2}{b^4}\left(\frac{4d}{b} - 1\right) + \frac{2h_1(b - mh_1)(b - 2mh_1)}{yb^5} - \frac{m}{b^2}\right\}x^3.$$

$$q = \left\{4Wm(b - 3d) + \frac{h_1^2(3b - 2mh_1)}{y}\right\}\frac{x}{b^3}$$

$$+ \left\{6Wm(3d - b) - \frac{3h_1^2(b - mh_1)}{y}\right\}\frac{x^2}{b^4}.$$

W is total weight resting on the horizontal plane containing the point considered, d the horizontal distance of the centre of gravity of W from the inner end of the same horizontal plane, b the width of dam at this plane, h_1 depth of water above this plane, m the tan. of angle of slope of dam at outer end of the plane, y specific gravity of the masonry, x the horizontal distance of the point considered from inner end of the plane. The principal stresses and the directions of the planes on which they act are found in the usual way. The formulæ are applied to the case of the Periyar Dam. In the *discussion*, **W. C. Unwin** pointed out that the effect of the earth, which is usually placed to some height against both sides of the dam, had been neglected. **A. Mallock** mentioned experiments on a model dam consisting of a heap of rubber sheets placed on a number of balls standing on a plane. **P. Forchheimer** gave arguments to show that the tension in a dam whose resultant pressure is within the middle third could not greatly exceed the hydrostatic pressure in its neighbourhood. F. R.

367. *Instability of Tubes under End Pressure.* **A. Mallock.** (Roy. Soc., Proc. Ser. A. 81. pp. 888-893, Dec. 22, 1908.)—The governing condition in the crumpling of the walls of a tube under end pressure is the constancy, to the first order, of the area of the surface midway between the interior and exterior of the wall of the tube. This surface may become unstable by deformation into any of the cylindrical harmonics of the type—

$$r = r_0 + a \cos n\theta / \cos (2\pi z/\lambda),$$

where θ, r, and z are the co-ordinates, and λ the length of a wave parallel to the axis. The order of the harmonic assumed by the deformed tube depends on h/r, the ratio of thickness of wall to radius, and will be such that the combined potential energy of bending and shearing will be a maximum. When $n = 1$ the folds are circular in plan, but the formulæ do not apply, as the assumption that the extension is small compared with the depth of the fold is untenable. When $n = 2$ the plan is a square, and when $n = 3$ a hexagon. With $n = 2$ and $n = 3$, experiments gave results corresponding fairly with the assumption that the extension is small. The calculation of the potential energy due to small deformations of either the tubular or completely crumpled surface can be calculated by the use of recognised functions, but this does not appear to be so in the intermediate stages, where the strain of the mid-wall surface is not small. A consideration of the distortion of a surface in the form of a circular cone is given. Further, as rectangular sheets may be folded and bent into a series of conical surfaces, and then joined edge to edge without straining, a model consisting of folded planes can be constructed the character of whose surface will be analogous to, but not identical with, the intermediate stages of crumpling of a tube by end pressure. F. R.

368. *Measurement of Low Pressures.* **K. Scheel** and **W. Heuse.** (Deutsch. Phys. Gesell., Verh. 11. 1. pp. 1-15, Jan. 15, 1909. Zeitschr. Instrumentenk. 29. pp. 14-20, Jan., 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—In the author's instrument a thin copper diaphragm separates two chambers, the difference between the pressures in which is to be measured. The movement of the diaphragm is measured by a Fizeau interference system. Below 0·1 mm. the pressures are measured to ½ per cent., and very small pressures to an absolute error of 0·00001 mm. The

sensitiveness of the instrument is such that an alteration of pressure of 0·001 mm. corresponds to 4 interference bands of yellow helium light. With pressures over 0·1 mm. the alterations of pressure are proportional to the movement of the diaphragm within ½ per cent. Within the limits of error air is not found to depart from Boyle's law. Comparative measurements made with a McLeod manometer were in close agreement with the results given by the diaphragm instrument, from which the truth of Boyle's law at much higher pressures than those with which the diaphragm manometer deals is inferred. F. R.

369. *Principles of Mechanics.* **S. A. Reeve.** (Engineer, 106. pp. 640–642, Dec. 18, 1908.)—Criticism of Newton's laws as based on limiting cases. Concepts as based on energetics. Relative action of two bodies is orbital, with conservation of energy but with constant periodic transformation of kinetic into potential energy, and *vice versâ.* Illustrations from cannon-shot fired horizontally with increasing muzzle-velocities; fall to the earth; circular orbit; elliptical orbits; hyperbolic paths without return to the earth. The potential energy between two freely moving bodies in a change from a mutual distance s_0 to a greater s_1, is $M_1M_2(s_1 - s_0)/s_0s_1$, of which $E_p = Wh$ is a special case; and, v_0 being the velocity under smaller s, that is, v_0 being the greater velocity, the kinetic energy is $\frac{1}{2}M_1M_2(v_0^2 - v_1^2)/2(M_1 + M_2)$, which, when M_1 is very large relative to M_2, becomes the ordinary approximation $E_k = \frac{1}{2}M_2v_0^2$. In purely circular orbital motion the centripetal is equal to the centrifugal force, *i.e.*, $cM_1M_2/r^2 = M_1M_2V^2/(M_1 + M_2)r$; or $c/r = V^2/(M_1 + M_2)$; or if r increase V must diminish. If r increased while the motion remained circular, the space energy absorbed would be twice the kinetic energy given out by the slowing down of the pair; but the motion does not remain circular; it becomes elliptical or hyperbolic, and the energy is conserved. Purely circular or tangential movement does not embody energy merely by virtue of its velocity, upon the same terms as translational motion. A. D.

370. *Ether Stress, Gravitational and Electrostatical.* **F. Purser.** (Roy. Irish Acad., Proc. 27. Section A. pp. 194–204, Jan., 1909.)—In his great epoch-making work on "Electricity and Magnetism," Maxwell, in conformity with his general line of thought, which always looked for action in a medium in place of action at a distance, proposed the problem of accounting for the action of static electricity by strains in the ether. This problem he considered himself to have so far solved as to indicate the general state of stress which must be postulated in the ether, leaving for further discussion the state of strain which would produce this stress. He afterwards ("Attraction," *Encycl. Brit.*) endeavoured to account by a similar state of stress for the phenomena of gravitation, the deduction of strain from stress being, however, as before, left untouched. Unfortunately in both problems the state of stress assumed in the ether was not one for which a system of strains could be found, assuming the ether either to be a homogeneous isotropic medium, or even one of general Greenian æolotropy. The author here shows that the Maxwellian stress is not necessary, but that the phenomena can be completely saved by a system of stress deduced from a certain system of strains according to the laws of a homogeneous isotropic medium. The problem is stated thus. Consider in an indefinite free ether certain specks, whether of matter or free electricity, introduced. The effect of these will naturally be to produce displacements of the ether around them. What, then, we have to do is to assign certain forms of displacement, such that the surface tractions over a very small cell shall produce a resultant force which shall vanish if the cell contains no speck of gravitating matter in the one problem, or of free electricity in the other; but in case such should be included shall be identical with the gravitation force, or electric force in either case on the speck. The subject is then developed mathematically and, on certain assumptions up to negligible compressibility, the strain quadric is obtained from which the following corresponding stresses are deduced: The electric stress would, on the conditions imposed, consist of a tension along the line of force, accompanied by a pressure of *half* the amount in all directions perpendicular to the line of force. The gravitational stress would similarly consist of a *pressure* along the line of force accompanied by an equal *tension* of *half* the amount in all directions perpendicular thereto. Hence, in the cases discussed, the stress is different from the Maxwellian. E. H. B.

371. *Laws of Molecular Flow and Internal Viscosity Flow of Gases through Tubes.* **M. Knudsen.** (Ann. d. Physik, 28. 1. pp. 75–130, Dec. 28, 1908. Copenhagen Univ., Oct., 1908.)—The author finds that in the case of flow through a tube the diameter of which is vanishingly small compared with the length of the tube and the mean free path of the gas molecules, one is dealing with a molecular flow, for which the law holds, $Q_t = \frac{1}{\sqrt{\rho_1}} \frac{p_1 - p_2}{W}$. Hence Q_t is the amount of gas streaming through in the unit of time, ρ_1 the specific gravity of the gas under the pressure of 1 dyne/cm.^{2}, and at the temperature of the tube. The streaming takes place from pressure p_1 to pressure p_2, all in absolute units. The magnitude W depends only on the dimensions of the tube and can be expressed $W = \frac{3\sqrt{\pi}}{8\sqrt{2}} \int_0^L \frac{o}{A^2}\, dl$, where L is the length of the tube, o is the circumference, and A the area of a nominal section at the distance l from the end of the tube. The theoretically found law is confirmed by experiment. A. F.

372. *Local Intensification of Draught caused by Presence of an Inclined Rod.* **A. H. Gibson.** (Manchester Lit. and Phil. Soc., Mem. 53. 5. pp. 1–10, Dec. 31, 1908.)—An investigation of the amount of truth in the old belief that a poker, placed with its lower end against the fender and the other end reared against the bars of the grate induces a fire to burn up. Observations showed that with a gentle horizontal blast against the poker a directive influence is felt over a region about 8 in. in diam. mostly below the poker. G. E. A.

373. *New Physical Proof of the Earth's Rotation.* **O. Tumlirz.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 819–841, June, 1908.)—It is here shown mathematically that if liquid is flowing radially outwards between two horizontal discs, the lines of flow will be strictly straight only if the discs and vessel be at rest, and will assume certain curves if the vessel and the discs are in rotation, as, for example, due to the earth's diurnal rotation. An elaborate experimental arrangement was set up in a vault, with very steady temperature near that of the maximum density of water so as to avoid convection disturbances. The stream lines were marked by coloured liquids and the effects photographed. These were in general accord with the predictions of theory and the supposition that the earth is rotating about its axis. E. H. B.

374. *Molecular Diameters.* **W. Sutherland.** (Phil. Mag. 17. pp. 320–321, Feb., 1909.)—In the calculation of molecular diameters from electrical data Jeans [see Abstract No. 373 (1905)] took no account of the effect of cohesional forces in the viscosities, conductivities, diffusivities, and collisional virials of gases which he used. Now it has been shown (Ibid. ser. 5. 36. p. 507, 1893) that if $2a$ is the diam. of a molecule, and C a parameter proportional to the mutual potential energy of two molecules in contact, T denoting the absolute temperature, the molecules behave as if devoid of attractive force, but enlarged so that $(2a)^2$ is replaced by $(2a)^2(1+C/T)$. Thus the temperature law of the viscosity of a natural gas is $\eta \propto T^{\frac{1}{2}}/(1+C/T)$, instead of the law $\eta \propto T^{\frac{1}{2}}$ which holds for the ideal perfect gas. On this account the quantities given by Jeans as the diameters of molecules $2a$, are in reality $2a(1+C/T)^{\frac{1}{2}}$. By means of the values of C and with $T=273$ it is easy to obtain the true values of $2a$. In the Landolt-Börnstein-Meyerhoffer *Tabellen* values of C for many of the gases in the list of Jeans are given, and also values of viscosity in other cases, enabling C to be calculated. In the table below are given the values of C for the different gases, those calculated being in brackets. Strictly the same sort of correction ought to be applied separately to the four methods used by Jeans for finding $2a$, but it is practically as useful at the present stage to apply the correction to his mean values obtained from the results of his four methods. These are given in the second column:—

Gas.	$2a(1+C/T)^{\frac{1}{2}} \times 10^8$.	C.	$2a \times 10^8$.
Hydrogen	2·03 cm.	72	1·81 cm.
Helium	1·81	76	1·60
Carbon monoxide	2·86	(156)	2·28
Ethylene	3·81	249	2·75
Nitrogen	2·91	110	2·46
Air	2·84	115	2·38
Nitric oxide	2·82	(195)	2·15
Oxygen	2·73	128	2·25
Argon	2·79	160	2·22
Carbon dioxide	3·36	258	2·41
Nitrous oxide	3·52	(167)	2·77
Chlorine	4·11	(199)	3·13
Water-vapour	3·39	...	...
Ethyl chloride	4·68	...	...

Water-vapour and ethyl chloride at ordinary temperatures are too far from the condition of a typical gas as regards the conditions of collision to permit of a satisfactory estimation of C without special experiments and discussion. A. W.

375. *Influence of the Character of the Surface on the Diurnal Variation of Vapour Pressure.* **M. Rykačev [Rykatcheff], Jr.** (Bull. Acad. Sci., St. Pétersbourg. Meteorolog. Zeitschr. 25. pp. 501–510, Nov., 1908.)—The diurnal variation of vapour pressure shows two distinct types. Type 1 follows closely the diurnal variation of temperature, and shows a minimum about the time of minimum temperature, *i.e.*, in the early morning, and a maximum in the early afternoon. Type 2 shows a semi-diurnal variation with maxima at about 9 or 10 a.m. and 8 or 9 p.m., and minima in the early morning and the early afternoon. The afternoon minimum, which is probably due to convection currents, is the characteristic feature of this type. The author proceeds to investigate the influence of a water surface, a land surface, and a snow surface on the diurnal variation. Over the ocean, for which he can only make use of the results for a few scientific expeditions, he reaches the general conclusion that type 2 predominates in tropical latitudes, especially on cloudless days, and that type 1 predominates in higher latitudes. Over land type 1 prevails throughout the year in tropical and sub-tropical regions (Allahabad and Mexico), whereas in higher latitudes (Pavlovsk, Paris, Nukuss) type 2 is characteristic of summer and type 1 of winter, but even in the latter season the results for cloudless days, if taken alone, show an indication of type 2. The effect of a covering of snow is to make type 1 predominate very markedly, no matter whether cloud be present or absent. R. G. K. L.

376. *Sizes of Raindrops.* **W. Schmidt.** (Meterolog. Zeitschr. 25. pp. 496–500, Nov., 1908.)—The author's starting-point is a work by A. Defant on the measurement of the sizes of raindrops, in which it is shown that the drops in a given shower tend to have their weights in the ratios 1 : 2 : 3 : 4 : 6..., the ratios 1 : 2 : 4 : 8... being of most frequent occurrence [Abstract No. 2020 (1905)]. The development of such a distribution from an initial state of a large number of small drops of equal size can be explained by the assumption that only drops of equal size or of sizes in the ratio 1 : 2 can coalesce. After touching on the difficulty in the way of coalescence occurring after violent collision, the author shows that there are forces at work tending to draw together drops of equal size. If two spheres of equal radius R and density σ move through a fluid along parallel paths, the line joining their centres, $2a$, being normal to the paths, the stream lines give an apparent attraction between the spheres of magnitude $(3/16)\sigma\pi v^2(R^6/a^4)$, where v is the relative velocity of the spheres with regard to the fluid. This force can only be effective in drawing the spheres closer together if v is the same for both. In the case of falling drops this is the case when the drops are of equal size. The time required for drops originally $2a$ cm. apart to come into contact is found to be $135{\cdot}7(a/v)\sqrt{(a^3/R^3)}$ sec. The height traversed in this time (assuming the drops to be so small that v is their limiting velocity) is independent of v but not of a and R. The author proceeds to show that the values for this height corresponding with selected values of a and R are such as might be expected to occur in the case of small falling raindrops.

R. G. K. L.

377. *Suggested Explanation of the Isothermal Layer.* **W. J. Humphreys.** (Astrophys. Journ. 29. pp. 14–32, Jan., 1909.)—After summarising the present state of our knowledge of the distribution of the vertical temperature gradient in the atmosphere and the various hypotheses to explain the existence of the upper inversion or isothermal layer, the author proceeds to offer an explanation of the latter, based on consideration of the amount of radiation received by it from the sun and the earth respectively. The energy received by a unit area placed parallel to an infinite black radiating surface is independent of the distance from that surface. Consider now a body placed between two parallel black surfaces of infinite extent and at temperature $T_1°$ absolute. The body will also assume the temperature $T_1°$. Now let a slab of this substance, 1 cm. square and δt thick, be placed parallel to the large planes, and let H_λ be the number of heat units of wave-length λ, they supply to it per sec., and let A_λ be the number of units of this energy which it absorbs per sec. Then if E_λ be the number of units of energy of the same wave-length it radiates per sec. as a result of its hotness alone, the following relation is given by the Stewart-Kirchhoff law $\left(E_2 \Big/ \frac{A_2}{H_2}\right)_{\lambda, T_2} = (R_2)$, where R_2 is the number of heat units radiated from a black body at temperature T_2. But the state is a steady one, and therefore $E_2 = A_2$ and $R_2 = H_2$. Now let one of the parallel surfaces be removed and the other retained at temperature T_2. The small slab will come to a new state of equilibrium at a temperature T_1, and give the relations $\left(E_1 \Big/ \frac{A_1}{H_1}\right)_{\lambda, T_1} = (R_1)$. Since H_2 is the radiation per sec. incident from the two planes jointly, while H_1 is the corresponding amount from only one of them at the same temperature, $H_2/H_1 = R_2/R_1 = 2$. But from the Stefan-Boltzmann law $R_2/R_1 = T_2^4/T_1^4 = 2$, and hence $T_2/T_1 = 119/100$. The second condition above described, *i.e.*, the single radiating black surface heating an object in its neighbourhood, is analogous to the effective radiating surface of the earth at temperature T_2, and the dry diathermanous atmosphere above the surface of the upper inversion at temperature T_1. Experiment shows that T_1 is somewhere about —55° C. Substituting this value in the equation given above, we have $T_2 = 259°$ abs. But this is about the temperature required by the solar constant for the effective radiating layer, *i.e.*, a layer of dense water-vapour—the equivalent nearly at this temperature of a black surface—that radiates the given amount of heat [Abbott and Fowle, Abstract No. 1380 (1908)]. The effective temperature is found in middle latitudes about 8 km. above the surface in winter and 5 km. in summer. The absorption of direct solar radiation in the ultra-violet by ozone is suggested to account for the frequently observed positive temperature gradient in the isothermal layer. Most of the solar radiation reaches the lower levels of the atmosphere and the earth, where it is absorbed and there emitted again as long waves, for which water-vapour is nearly opaque. In this way the lower atmosphere becomes heated and rises, in which act it cools by expansion and by radiation until it reaches a minimum temperature, determined mainly by the sum-total of the energy emitted from lower levels. Above this place the temperature slowly rises, presumably because of the absorption of direct solar radiation. R. G. K. L.

378. *Remarkable Temperature Inversion.* **W. Köppen.** (Meteorolog. Zeitschr. 25. pp. 570–571, Dec., 1908.)—On Nov. 16, 1908, kite ascents revealed an inversion of temperature of unusual intensity over North Germany. At Hamburg the temperature at ground-level was —6·5° C., wind SE., fresh, sky cloudless. At 100 m. above the ground the temperature was —7·5°. Above this level temperature increased rapidly, and at 750 m. +7·5° was met with. At 2,050 m. the temperature was +8·5°, relative humidity only 24 per cent. Above 200 m. the wind was strong from S. or SSW. At Lindenberg, near Berlin, the temperature at ground-level (122 m. above M.S.L.) was —8·5°, and at 950 m. above M.S.L. it was +5·6°. R. G. K. L.

379. *Kite and Balloon Observations of the Denmark Expedition to Greenland.* **A. Wegener.** (Meteorolog. Zeitschr. 26. pp. 23–24, Jan., 1909.)—The Denmark Expedition made in 1906–1908 more than 100 kite ascents (up to 3,100 m.), and sent up captive balloons (to 2,800 m.) 25 times, from their station in North-east Greenland, near Cape Bismarck, lat. 76¾° N. Winds from the N. and W. predominated, the NW. winds being of Föhn character, to study which a second station was established, 60 km. up the fjord. Easterly winds, cold and damp, were rare, and confined to the lower 500 m.;

several times NW. winds were observed above them. The temperature stratification was very pronounced, and temperature inversions, amounting to 8° frequent in the lowest 30 m. The temperature gradient was generally very high in the 2 m. above the surface. Sometimes, however, the surface was warmer than the air above it, owing to the heat liberated when the sea-water was freezing. Thus two kinds of mirage were observed and photographed. In one case rain fell at a surface temperature of —10°, while the balloon registered temperatures above freezing-point. **H. B.**

380. *Temperature on the Zugspitze and at Munich at 3,000 m.* **A. Schmauss.** (Meteorolog. Zeitschr. 26. p. 24, Jan., 1909.)—Registering balloons were sent up in 1906–1908 in the free atmosphere at Munich on 44 days; the Zugspitze Observatory is at a height of 3,000 m., and the distance from Munich is 90 km. In 34 cases the mountain was colder than the free atmosphere, in 2 cases the temperatures were the same, in 8 cases the mountain was warmer. The mean of the 44 cases is that the mountain-top was colder than the free atmosphere at the same height by 1·6° C.; as the balloon ascents took place at 8 a.m., however, before the mean temperature would have established itself on the mountain, the more correct figure is 1·1° C. Among the causes which keep the free atmosphere warmer the author considers the presence of isothermal layers (convection currents destroy them on the mountains) which have a tendency to raise the isothermal surfaces to a higher level. [Compare Abstract No. 1870 (1908).] **H. B.**

381. *Studies of Atmospheric Vortices. IV. The De Witte Typhoon of August 1–3, 1901.* **F. H. Bigelow.** (Monthly Weather Rev., Washington, 36. pp. 328–333, Oct., 1908.)—The De Witte typhoon is discussed as another example [see Abstract No. 16 (1909)] of a dumb-bell vortex. The typhoon has been studied by L. Froc, of Zi-ka-wei, and J. Algué, of the Manila Observatory, and the author examines also the data from the China Coast Meteorological Register and the Central Meteorological Observatory of Japan, lat. 20 to 30°, longitudes 118 to 129° E. It is suggested that sun-spots may be regarded as hurricanes of the dumb-bell vortex type. **H. B.**

382. *Diurnal and Semi-diurnal Atmospheric Variations.* **H. H. Clayton.** (Nature, 79. pp. 397–398, Feb. 4, 1909.)—The semi-diurnal pressure variation has been explained from the two facts, (1) that the daily variation of temperature is not simple harmonic, and when analysed there is a definite semi-diurnal component; (2) that the period of free oscillation of the atmosphere lies very near 12 hours. Analysis of the normal variation of temperature at different levels above Blue Hill Observatory gives the following results :—

Height.	
15 m.	$45{\cdot}4 + 8{\cdot}38 \sin (284 + x) + 1{\cdot}63 \sin (73 + 2x) +$ &c.
500 m.	$44{\cdot}7 + 0{\cdot}47 \sin (18 + x) + 1{\cdot}67 \sin (18 + 2x) +$ &c.
1,000 m.	$40{\cdot}2 + 0{\cdot}09 \sin (85 + x) + 0{\cdot}35 \sin (344 + 2x) +$ &c.
1,500 m.	$36{\cdot}0 + 0{\cdot}90 \sin (47 + x) + 0{\cdot}80 \sin (0 + 2x) +$ &c.

The epoch in each case is midnight. We see thus that at increasing altitudes the first-order term becomes much smaller than the second-order one. **R. G. K. L.**

383. *Sunshine Observations at Potsdam.* **W. Marten.** (Königl. preuss. Meteorolog. Inst. No. 192. Meteorolog. Zeitschr. 25. pp. 523–525, Nov., 1908.)

—The paper gives a detailed discussion of the results of records continued over the decade 1893 to 1902. The second part of the paper is devoted to a discussion of the relative merits of the Campbell-Stokes (burning) and Jordan (photographic) recorders. The use of the former is recommended, as its indications are more nearly comparable. R. G. K. L.

384. *Magnetic Effect of Winds.* **W. J. Humphreys.** (Terrestrial Magnetism, 13. pp. 153–154, Dec., 1908.)—The author calculates the magnetic effect of the current carried by a wind of 30 m./sec. (60 miles per hour) consisting of ionised air containing an excess of 2,000 ions of one class per c.cm. and blowing along the magnetic meridian. He finds that it amounts for this extreme case to approximately one-fortieth of a γ. Hence, unless the numerical excess of one class of ions is many times greater than the observations have shown it to be, magnetic effects due to wind storms, while undoubtedly existing, are too minute certainly to be detected among the much greater and irregular disturbances due to other causes.

R. G. K. L.

385. *The Sea-water of the English Channel.* **A. Letalle.** (Comptes Rendus, 147. pp. 1090–1092, Nov. 30, 1908.)—The author has repeated the observations mentioned in Abstract No. 392 (1908) between Dieppe and Newhaven on July 28. The former general conclusions are confirmed. The water was warmer on both shores than in the open Channel, but near England again colder than near France. The density increase observed on the way from France to England was less regular than in Oct., 1907. Two maxima of density were found, which may be due to a bifurcation of the fresh water current from the Seine; this current would be more powerful in July than in Oct. H. B.

386. *Destructive Earthquakes in the Shinano-gawa Valley and on the Japan Coast.* **F. Omori.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 15. pp. 288–293, April, 1908.)—Notes on earthquakes, chiefly the Sango earthquake of 1828 and the Zenkoji earthquake of 1847; the latter was accompanied by 44,000 landslips. The earthquakes of 1886, 1887, 1890, 1897, and 1899 occurred in the same zone, but not at the same centres. The 14 earthquakes along the sea-coast are divided into 5 groups; only in the first group of 5 is a fairly regular interval of about 18 years noticeable. H. B.

387. *Microseisms of Long Duration.* **J. C. Solá.** (Comptes Rendus, 147. pp. 1361–1362, Dec. 14, 1908.)—By means of vertical pendulum seismographs the oscillations of long duration have been recorded at the Fabra Observatory, Barcelona, since 1906. These appear to have no direct relation to the changes of barometric pressure or of temperature, and often last for many hours. The average oscillation period is about 5 sec. Attention is drawn to the occurrence of numerous volcanic vents about 100 km. north of Barcelona, which, although now extinct, are of recent geological origin. C. P. B.

388. *Earth Temperatures at Osaka.* **T. Okada.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 21. pp. 427–438, Nov., 1908.)—The observatory is situated 5 m. above sea-level. Observations have been made since 1895. The thermometers at 0, 0·1, 0·3, 0·6 m. are ordinary mercury instruments with long stems. For the depths of 1·2, 3·0, 5·0 m. earth-thermometers are used, the thermometer being attached to a copper chain and contained in an

iron pipe which is driven into the ground. Hourly readings are taken with the former, and two readings daily, at 10 a.m. and 10 p.m., with the latter instruments. At 0·6 m. the diurnal variation is less than half a degree. The annual variation ranges from 29·6° at the surface, 24·9° at 0·3 m., 17·4° at 1·2 m., 8·3° at 3 m., to 3·2° at 5 m. The temperature at the depth of 3 m. is too high; the reason is not clear. The heat-exchanges calculated after Bezold's method are: diurnal exchange, 42·8 gm.-cals. (ranging from 28 in Jan. to 61 in May); total annual exchange, 2,240 gm.-cals. The thermal conductivity of the soil decreases regularly with the depth; the diffusivity of the soil has its maxima and minima in the different months at different depths. H. B.

389. *Earthquake of Dec.* 28, 1908. **A. Angot.** (Comptes Rendus, 148. pp. 62–63, Jan. 4, 1909.)—The curve registered on Dec. 28, 1908, at Parc Saint Maur is noted as a very remarkable one. The oscillations commenced suddenly at 4h. 23·9m. G.M.T., while the large waves came on at 4h. 27·0m. The duration of the preliminary tremors, 3·1m., is distinctly indicated on the reproduction of the trace. On one occasion the E.-W. component reached an amplitude of 14 mm. The oscillations were less marked by 4h. 50m., scarcely perceptible at 5h. 20m., and had altogether ceased at 6h. 25m. Distance of epicentre is computed as 1,580 km., which is very nearly that of Messina. The magnetographs also showed disturbances which were probably mechanical because of their different nature to those caused by the normal magnetic variations. C. P. B.

390. *Kew Records of Italian Earthquake.* **C. Chree.** (Nature, 79. pp. 280–281, Jan. 7, 1909.)—Reproductions are given of the traces from the Milne seismograph and declination magnetograph at Kew, on Dec. 28, 1908, coinciding with the time of the Messina earthquake, which also exhibit certain peculiarities. The seismograph trace shows a very sudden arrival of seismic waves of some magnitude at 4h. 23·6m. a.m. G.M.T. If these represent "preliminary tremors" from an earthquake originating in Italy, about 2,000 km. away, the large waves would be expected only after an interval of about 7 min., and in ordinary cases the maximum amplitude would occur some little time after the commencement of the large waves. In the present case, however, it is seen that the maximum is shown either at 4h. 31·1m. or 4h. 32·7m., and is of such magnitude that the end of the boom must have moved more than 17 mm. It is unusual for the Kew magnetographs to show any indications of earthquake movement, but such took place in this instance. Several unmistakable burrs are seen in the declination trace, and are ascribed to actual mechanical disturbance. The period of the declination magnet was 10 sec., that of the seismograph boom 17 sec. C. P. B.

391. *Water-vapour in Sun-spots.* **A. L. Cortie.** (Astrophys. Journ. 28. pp. 379–383, Dec., 1908.)—In a previous paper [Abstract No. 2008 (1907)] the probability of there being lower temperatures in the regions of sun-spots than in the general photosphere was indicated from a comparison of the behaviour of the bands of titanium oxide in the spectrum of Mira Ceti at times of maxima of different degrees of brilliancy, with their appearance in the spectra of spots. The present paper discusses the probability of the temperature being so reduced that water-vapour in the form of superheated steam may be present. Evidence is adduced for this view from the marked behaviour of certain of the so-called *telluric* lines in the solar spectrum, these being widened to varying extents in the spot spectrum. It is mentioned, however, that other observers working with more powerful dispersion do not find the widening, and in many cases the affected line is found to be due to a closely adjacent solar line and not to the telluric line. C. P. B.

392. *Messina Earthquake of December* 28, 1908. **A. Lacroix.** (Comptes Rendus, 148. pp. 207–209, Jan. 25, 1909.)—According to Riccò's preliminary report from Catania, the earthquake was not accompanied by any volcanic manifestation of Etna or Stromboli. The earthquake was evidently tectonic, and connected with the fault along the coast-lines of Sicily and Calabria. The characteristic feature of this earthquake was that Messina was the epicentre of the elliptical area of disturbance. The sea did damage particularly on the Calabrian coast, receding in the first instance. H. B.

393. *Solar Magnetism.* **W. J. Humphreys.** (Terrestrial Magnetism, 13. pp. 145–152, Dec., 1908.)—Recent investigations by Hale have shown (1) that the sun-spot areas are of lower temperature than the surrounding regions; (2) that they are centres of violent cyclones; (3) that they are accompanied by magnetic fields of great intensity. These three features are elaborated in the present article by dynamical reasoning, with the result that on all three points no definite agreement can be found with the known terrestrial causes of similar magnitude. If the surface temperature of the sun be taken as 6,000° C., that of an isolated mass floating above it, undisturbed by convection, would probably be at least 5,000° C., and the cooling effect observed must be attributed to violent explosions of some kind, causing great expansion. Regarding the cyclonic movements, it is shown that they are unlikely to be due to barometric gradients such as produce the terrestrial atmospheric cyclones. The observed field in spots, about 2,900 c.g.s., does not appear sufficient to account for any direct action from the sun being the cause of terrestrial magnetic storms; it is suggested that by virtue of the differences in temperature of the spots from the other parts of the solar surface they may emit ions at a different rate and at a different velocity, and that the resulting differential effects in the density and velocity of the electrons, as they stream past the earth, may cause irregular effects in the earth's magnetic field. [See Abstracts Nos. 2001 (1906); 804 ((1907); 1586 (1908).] C. P. B.

394. *Magnetic Action of Sun-spots.* **A. Schuster.** (Nature, 79. pp. 279–280, Jan. 7, 1909.)—The discovery by Hale of the Zeeman-effect in sun-spot spectra having revived the idea of a direct magnetic action originating in the sun and observable at the surface of the earth, the author outlines a method of making an approximate estimate of the magnitude of the disturbance which might be produced by such a direct action. Considering the disturbed area of the spot as a magnetic pole, with the opposite pole at the other end of the solar diameter, the vertical force is computed, and its ultimate value at the distance of the earth comes out about $4{\cdot}5 \times 10^{-6}$ c.g.s., which on the Greenwich curves would be represented by a displacement of about $\frac{1}{10}$ mm. It is therefore concluded that the magnetic disturbances hitherto associated with the state of the sun's surface cannot be accounted for by the direct magnetic action of Hale's electric vortices. C. P. B.

395. *Diameter of Mercury.* **Stroobant.** (Annales Astronom. de l'Observatoire royal de Belgique, Vol. 12, Part I, 1908. Nature, 79. p. 282, Dec. 24,

1908. Abstract.)—From observations made during the transit of Mercury on Nov. 13–14, 1907, the author deduces corrections for the position and diam. of Mercury. At unit distance the diam. works out at 6″·16, equivalent to an actual diam. of 2,282 km. C. P. B.

396. *Spectrum of Mars.* **V. M. Slipher.** (Astrophys. Journ. 28. pp. 395–404, Dec., 1908.)—All observations of the spectrum of the planet Mars previous to 1895 were made visually, and it is doubtless owing to the subsequent application of continually improved photographic investigation that the recent definite conclusions have been rendered possible. One of the chief difficulties with the visual determinations was the absence of a suitable comparison spectrum which could be examined simultaneously with that of the planet. The photographs reproduced were taken at Flagstaff, Arizona, under ideal conditions. At the altitude of 7,250 ft. most of the water-vapour from the earth's atmosphere is avoided, and the observations were made in the winter months when the percentage of vapour was least. Special red-sensitive plates enabled the spectrum to be obtained as far as the A line, thus permitting the *a* band of water-vapour to be used as standard. Close discussion of the relative intensity of this *a* band when the moon's spectrum was photographed at the same altitude show most distinctly that it is relatively much stronger in the Mars spectrum. As this is undoubtedly associated with water-vapour, the conclusion is that water-vapour is present in the atmosphere of Mars. The results suggest the presence of *snow-caps* and a comparatively *moderate* temperature rather than *hoar-frost* caps and a *low* temperature. C. P. B.

397. *Surfaces of Jupiter's Satellites.* **J. C. Solá.** (Astronom. Nachr., No. 4290, p. 290, Dec. 11, 1908. Nature, 79. p. 282, Dec. 24, 1908. Abstract.)—Results of observations during opposition of 1907–8, with drawings. Satellite I. appears to be ellipsoidal, with polar flattening about one-fifth the major axis. Direction of longest axis not parallel to bands on Jupiter. Satellite II. appears round. Satellite III. shows white polar caps, equatorial bands, and dark areas. Satellite IV. shows only faint north polar cap. Observations of Titan indicate presence of atmosphere. [See Abstract No. 1911 (1908).] C. P. B.

398. *Saturn's Rings in October,* 1908. (Roy. Astronom. Soc., Monthly Notices, 69. pp. 39–41, Nov., 1908. From Royal Observatory, Greenwich.)—Critical examination of the rings of Saturn, in consequence of an announcement that a new dusky ring had been observed at the Geneva Observatory. Traces of a dusky border to the outer ring were seen on several occasions, but did not appear constant. C. P. B.

399. *Rings of Saturn.* **W. W. Campbell.** (Phil. Mag. 16. p. 949, Dec., 1908.)—Lowell has stated that the definition at Flagstaff is so much superior to that at other stations as to permit of finer planetary details being discerned. Campbell does not accept this, and in support of his contention states that the inner condensation in Saturn's rings, seen *double* with great ease by Aitken, using the 36-in. Lick telescope, and with some difficulty by Barnard using the 40-in. Yerkes refractor, was not seen double by Lowell. Also that Lowell located a "gap" or most conspicuously vacant spot in the ring system 5¼″ west from the ball of the planet, and another one like it 5¼″ east of the ball. Aitken, observing on the same night, noticed

that the light was relatively very weak at these points, but with the greater light-gathering power of the 36-in. telescope, he was able to see with certainty a faint line of light extending right across each of Lowell's conspicuous vacant gaps. C. P. B.

400. *Distribution of Aphelia of the Asteroids.* **E. Belot.** (Comptes Rendus, 147. pp. 1460–1463, Dec. 28, 1908.)—On examining the positions given for the aphelia of 632 of the asteroids, the author finds evidence of selective grouping in longitude. There are 419 of the small bodies whose aphelia lie about the longitude circle 135–315°, and if the eccentricities be considered, most of those of greater eccentricity than 0·20 lie on this same circle, while those of less eccentricity than 0·08 are more uniformly distributed along the ecliptic. C. P. B.

401. *Triplication of Comet of* 1556. **G. Forbes.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 152–162, Dec., 1908.)—The comet of 1556 was expected to return in 1848, but did not do so. On examining the elements of the comet, the author found certain peculiarities which caused him to believe that the body had been perturbed by some unknown planet, causing it to break up into three portions, which became visible successively as the comets of 1843 I., 1880 I., and 1882 II. These three comets have long been regarded as associated, in that their orbits are similar, although not identical; they all have retrograde motion, and all approach very close to the sun's surface at perihelion; the points of aphelia are also very close together. It is suggested that a new planet should be looked for in the position, Long. 215° 31′; Lat. 33° 58′ (1908). C. P. B.

402. *Focal Images of Nova Persei and Wolf-Rayet Stars.* **E. E. Barnard.** (Science, 28. p. 849, Dec. 11, 1908. Abstract of paper read before the Astron. and Astrophys. Soc. of America.)—Hartmann has announced that the spectrum of Nova Persei changed to the nebular condition in the autumn of 1902. In 1906 it had again changed and was similar to that of the Wolf-Rayet stars, but observations during the interval being lacking, the exact time of change could not be stated. Observations of the focus were made with the 40-in. in 1901, 1902, and 1903, showing a change in accordance with Hartmann's spectroscopic observations. The focus became suddenly nebular about Oct. 1, 1902, when it was ¼ in. longer than for a star. This state lasted till Nov. of the same year, when it slowly returned to the stellar focus, becoming stellar about Feb., 1903. The last measure made was on Sept. 28, 1903, when the result gave −0·03 in. As all the Wolf-Rayet stars examined bore also a shorter focus than an ordinary star, the above result verifies Hartmann's later observation and also provides evidence for the date when the second change occurred. C. P. B.

403. *Determination of Angular Diameters of Stars and Astrophysical Questions concerning this Determination.* **S. Pokrovskij.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. No. 8. pp. 340–362 [Physical Part], 1908.)—From Rasch's law [see Abstract No. 2526 (1904)] and the Wien-Planck law, the author has deduced two expressions giving the angular diameters of stars in relation to their temperatures and photometric intensities. The temperatures of stars of the II*a* type are taken as being equal to that of the sun. The dimensions of the components of double stars of known parallax have been determined, and also their mean densities relative to that of the

sun. From two angular diameters of Algol, the temperature of the latter is found to be 19,000–12,000°. The temperature parallax of β Lyra is found to be 0·0032″, which corresponds with a period of 1,019 years occupied by light in traversing the path from this star to the earth. The temperature of the sun is calculated to be 6,270°. T. H. P.

404. *Diameter of a Fixed Star.* **P. A. MacMahon.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 126–127, Dec., 1908.)—The author proposes to attempt the determination of the diam. of a star by measuring the time taken for its occultation by the dark limb of the moon. With a star of parallax 0″·10, and of same actual diam. as the sun, this occultation time would be about $\frac{1}{500}$ sec. From other photographs Dyson has found that a star of magnitude 1·0 might possibly be photographed in about $\frac{1}{150}$ sec. If this can be secured by means of a rapidly moving film the problem might be solved. C. P. B.

405. *Faint Stars with Large Proper Motions.* **H. H. Turner.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 57–60, Nov., 1908.)—The existence of stars like Groombridge 1830, which is of 6·5 magnitude and has a proper motion of 700″ a century, larger than that of the brightest star known, suggested that there may be stars of faint magnitude with proper motions large enough to be measurable. Tests were made on plates taken for the Astrographic Chart, and on specially exposed plates, but the results are not decisive, and the conclusion from examinations of a considerable number of stars is that there seem to be few proper motions of over 20″ a century among the faint stars. C. P. B.

406. *Constancy of Period of Variable Star M5 (Libræ).* **E. E. Barnard.** (Science, 28. p. 848, Dec. 11, 1908. Abstract of paper read before the Astron. and Astrophys. Soc. of America.)—This is one of the Harvard Cluster variables, and has been observed with the 40-in. Yerkes during the past ten years, giving the period 12h. 2m. 7·8040s. ± 0·01781s. The light-curve shows that the star, after remaining faint for a large part of its period, rather suddenly begins to brighten, and reaches maximum in 1 hour. It remains but a short time at maximum, and the decrease for the first half-hour is almost as rapid as the rise. It then fades slowly for the next 6 or 8 hours to minimum. The entire light-change is about 1·2 magnitudes, from 15 m. ± to 14 m. ±. C. P. B.

407. *Light-fluctuations of α Herculis.* **F. Schlesinger.** (Science, 28. p. 850, Dec. 11, 1908. Abstract of paper read before the Astron. and Astrophys. Soc. of America.)—For a long time past this star has been regarded as an irregular variable with a period of 35 to 40 days. Frost and Adams have shown it to be a spectroscopic binary. Spectrograms obtained with the Mellon spectrograph of the Allegheny Observatory give a period of 2·05 days for the velocity variations, very different from that assigned to the light variations. Further observations at Harvard lead to the idea that the star is of the β Lyræ type, having a secondary minimum. On this assumption most of the complicated phenomena appear to be explicable. C. P. B.

REFERENCES.

408. *Transverse Oscillations of a Canal of Circular Section.* **R. A. Houstoun.** (Phil. Mag. 17. pp. 325–328, Feb., 1909.)—Mathematical.

409. *An Electric Barometer.* **R. Goldschmidt.** (Soc. Belge Élect., Bull. 25. pp. 661–664, Oct., 1908.)—The familiar arrangement in which the variation of resistance of a looped wire due to its being more or less immersed in mercury is here applied to the mercury barometer. L. H. W.

410. *Strength of Oval Tubes under Fluid Pressure.* **M. Westphal.** (Zeitschr. Vereines Deutsch. Ing. 52. pp. 2076–2077, Dec. 26, 1908.)—By considering the components of the forces at a point in the circumference of a tube as being the total pressures on the two chords at right angles to one another, formulæ for the bending moments and shearing force are readily obtained. Special consideration is given to the case in which the section consists of two semicircles joined by straight lines, and the bending moments at the ends of the longer and shorter axes are tabulated. F. R.

411. *Formulæ for Reinforced Concrete Beams.* **P. J. Robinson.** (Inst. Civ. Engin., Proc. 173. pp. 222–243, 1907–1908.)—Formulæ are derived, mostly in the usual manner, for use in design of reinforced beams; they are also presented graphically and in some cases in approximate forms. The effect of taking tensional resistance of the concrete into consideration is discussed in an appendix. F. R.

412. *Remarks on the Principle of Action and Reaction in Dynamics.* **M. Planck.** (Phys. Zeitschr. 9. pp. 828–830; Discussion, p. 830, Nov. 15, 1908. Paper read before the 80. Naturforscherversamml., Köln.)

413. *The Metric System.* **C. E. Guillaume.** (Soc. Int. Élect., Bull. 9. pp. 35–47, Jan., 1909.)—An interesting *résumé* of the present position of the metric system in all parts of the world. The distinction between the kilogram as a unit of mass (as originally intended) and the weight of 1 kilogram as a unit of force is being kept better in view. A. D.

414. *Gravitation.* **O. Keller.** (Comptes Rendus, 147. pp. 853–856, Nov. 9, 1908.)—The author attempts to explain gravitation as due to atomules radiating energy and producing pressures in the ether, which pressures concur in the regions outside two particles or masses but counterbalance one another in the lines joining these. A. D.

415. *Gravitation.* **C. V. Burton.** (Phil. Mag. 17. pp. 71–113, Jan., 1909. Paper read before the Physical Soc., May 8, 1908.)—Theory of gravitation as a secondary or residual effect, due to the influence of atomic matter on the propagation of compressional æthereal waves of enormous wave-length and velocity; mathematically worked out, with numerical applications. A. D.

416. *Relationship of Latent Heat of Fusion and Sublimation to Theory of Capillarity.* **R. Girtler.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 889–902, June, 1908.)—A theoretical paper, unsuitable for abstraction, dealing with the theory of capillarity and its relationship to latent heat of fusion and sublimation. F. J. B.

417. *Meteorology of the Adriatic.* **J. Hann.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 783–818, June, 1908.)—A discussion of the observations made at the lighthouse on the island of Pelagosa in the centre of the Adriatic since June, 1894. Interesting comparisons are given with the data from the neighbouring Austrian station at Lesina and with Luktschun, a station in Central Asia in practically the same latitude. R. G. K. L.

418. *Climate of Eastern Asia.* **A. J. Henry.** (Monthly Weather Rev., Washington, 36. pp. 364–368, Nov., 1908.)—Gives an interesting summary of the climate of China, Japan, and Eastern Siberia. Some useful temperature tables are appended. R. G. K. L.

419. *Absolute Determination of Solar Radiation from a Free Balloon.* **A. Coym.** (Meteorolog. Zeitschr. 26. pp. 24–25, Jan., 1909.)—Note on the method of conducting such observations with the aid of an Ångström electric compensation pyrheliometer. The mirror galvanometer is replaced by a d'Arsonval microvoltmeter made by Siemens and Halske. Two observers are required, one of whom has to keep the instrument vertical during the oscillations of the balloon. Particulars of determinations made during four ascents are given in "Ergebnisse der Arbeiten des Preuss. Aeronaut. Observatoriums bei Lindenberg, 1907." H. B.

420. *Thermodynamical Discussion of Balloon Observations.* **P. Schreiber.** (Meteorolog. Zeitschr. 26. pp. 25–27, Jan., 1909.)—The author shows how the data of two ascents made on Sept. 15, 1898, by Berson starting from London and reaching a height of 8,320 m., and by Suring starting from Berlin and reaching 6,200 m., can be analysed with the aid of his thermodynamical formulæ [see Abstract No. 1044 (1908)]. H. B.

421. *Transmission of Earthquakes through the Earth.* **O. Fisher.** (Cambridge Phil. Soc., Proc. 14. pp. 231–235, Oct. 15, 1907.)

422. *Propagation of Groups of Waves in Dispersive Media: Application to Waves on Water.* **T. H. Havelock.** (Roy. Soc., Proc. Ser. A. 81. pp. 398–429, Dec. 22, 1908.)—A mathematical consideration.

423. *Lick Observatory Eclipse Expedition, January,* 1908. **W. E. Rolston.** (Publications of Astronom. Soc. of the Pacific, No. 119, April, 1908. Roy. Astron. Soc. Canada, Journ. Vol. 2. No. 3. p. 115. Nature, 79. pp. 70–72, Nov. 19, 1908. Lick Observatory Bull. Nos. 131 and 132.)—Diary of the expedition and review of preparations and observations made during the total solar eclipse at Flint Island on Jan. 3, 1908. C. P. B.

424. *Photographic Light-curve of Variable Star σ Cassiopeiæ.* **J. A. Parkhurst.** (Astrophys. Journ. 28. pp. 278–283, Nov., 1908.)

425. *Zodiacal Light.* **E. A. Fath.** (Lick Observatory Bulletin, No. 142. Nature, 79. p. 143, Dec. 3, 1908. Abstract.)—Observations made to determine nature of a faint light which has been seen along the northern horizon of Mount Hamilton during the past summer. Probably due to zodiacal light. Northern boundary of light reached altitude of 46°. C. P. B.

426. *Solar Parallax.* **C. D. Perrine.** (Science, 28. p. 855, Dec. 11, 1908. Abstract of paper read before the Astron. and Astrophys. Soc. of America.)—From 281 photographs of the planet Eros secured on eighteen nights from Oct. 6 to Dec. 24, 1900, containing 823 images of the planet, the author deduces a solar parallax $= p = 8''\cdot8054 \pm 0''\cdot0025$. C. P. B.

427. *Jupiter during* 1907–8. **T. E. R. Phillips.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 33–39, Nov., 1908.)—Notes on the observations of Jupiter made with a 12½-in. equatorial reflector, giving details of surface markings with their form and colour, transit observations of spots in various latitudes, and special satellite phenomena. Rotation periods of numerous features are also specified. C. P. B.

428. *Light-fluctuations of Variable Stars.* **K. Pearson** and **J. Bell.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 128–151, Dec., 1908.)—Working on the correlation system it is found that there is a relation between light-fluctuation and period, being much higher for the short- than for the long-period variables. There is also for both types of variables an intimate relationship between the light range and light maximum. C. P. B.

LIGHT.

429. *New Form of Stellar Photometer.* **E. C. Pickering.** (Science, 28. p. 850, Dec. 11, 1908. Abstract of paper read before the Astron. and Astrophys. Soc. of America.)—An artificial star is formed by allowing the light from a small electric lamp to shine through a minute hole, placed in the focus of an auxiliary telescope. This is placed at right angles to the main telescope, and a piece of plane glass set at an angle of 45° reflects the artificial star into the eyepiece. A piece of opal or ground glass is placed over the hole, and the light of the artificial star is varied by moving the electric light along the axis of the small telescope by a known amount. The scale of the instrument thus depends on the law of inverse squares of the distances, instead of on the laws of polarised light, or on the empirical law found for wedge photometers. C. P. B.

430. *Powerful Cassegrain Reflector.* **Schaer.** (Astronom. Nachr., No. 4295. Nature, 79. p. 378, Jan. 28, 1909. Abstract.)—Description of a Cassegrain reflector of 40 cm. (15·7 in.) aperture at the Geneva Observatory. The difficulty usually experienced on account of diffused light from the inside of the tube has been eliminated by fitting a conical tube concentric with the main tube, and extending 15 cm. from the focal plane. Tests made with the instrument show that its intensity is greater than that of a crown flint refractor of equal aperture. C. P. B.

431. *The Photoheliometer.* **C. L. Poor.** (Science, 28. p. 848, Dec. 11, 1908. Abstract of paper read before the Astron. and Astrophys. Soc. of America.)—For determining minute changes in the diam. of the sun's disc a 25-ft. photographic heliometer has been mounted on the tube of the 40-in. Yerkes telescope. The lenses are of 2 in. aperture, with their centres fixed at a given distance apart such that the two solar images overlap. The common chord of these overlapping images is a measure of the diam. of the sun, and slight variations in the diam. produce relatively large changes in the length of the chord. C. P. B.

432. *Some Phenomena of the Persistence of Vision.* **F. Allen.** (Phys. Rev. 28. pp. 45–56, Jan., 1909. Paper read before the Roy. Soc. of Canada, May, 1908.)—The method of measuring the persistence of vision was described by the author in a previous paper [see Abstract No. 496 (1901)]. In front of the slit of a spectrometer is placed a sectored disc which, when rotated by an electric motor, interrupts the light, causing a flickering of the part of the spectrum under observation. By electrical means the speed of the disc is recorded on paper on a rotating drum, and thus the duration of a single flash of light can be accurately determined when the speed is such that the flickering just disappears. The duration of these light-interruptions in this case varies with the luminosity of the spectrum, and when plotted as ordinates against the wave-lengths of the colours observed gives a persistence-of-vision curve. It was observed that when the eye is protected from light by being blindfolded before the experiment the time of persistence of all colour impressions is increased. Observations of the persistence of vision were

made with red, yellow, green, and blue light after intervals of darkness adaptation of 1, 3, 5, 10, and 15 min. respectively. The adaptation curves show saturation after about 5 min. The max. effect occurs with the brightest colour used ($\lambda = 0{\cdot}567\ \mu$) and the minimum for the dullest colour, $\lambda = 0{\cdot}468\ \mu$. The author next obtains a series of curves after the retina has been fatigued by exposure to light of certain definite hues. It appears that with almost all colours the fatiguing effect of the light stimulus reaches its maximum in about 3 min., further exposure to light seeming to make no difference on the duration of light impressions. The most remarkable curves are those for yellow and blue light whose wave-lengths are 0·575 μ and 0·472 μ respectively. The latter is a straight line and the former is nearly a straight line. For these colours, therefore, the retina does not get appreciably fatigued. The difference between max. and normal readings varies with the wave-length. The graph of this difference is characterised by three elevations corresponding to the red, green, and violet of the spectrum. The two depressions correspond to yellow and blue rays. These two depressions agree with the fundamental yellow and blue of the Hering theory of colour vision. While the blue is nearly that chosen by Helmholtz and by König and Diderici as one of their fundamental colours, the wave-lengths of the maxima of the red and green elevations also are the fundamentals of those colours which have been selected by the last two writers. This curve with its three elevations seems to support the view that there are but three fundamental colour-sensations, which correspond to some hues of red, green, and violet. It was noticed that the persistence of colour impressions was not constant over all parts of the retina. When no flickering of the colour under observation was perceptible in the centre of the retina, a slight movement of the eye in any direction, so as to allow the light to fall on the peripheral portions of the retina, was always sufficient to destroy the apparent continuity of the light. The results of the experiments made show that the duration of all colour impressions diminishes as the distance from the centre of the retina increases. Interesting experiments were also made with light falling on the macula lutea. This spot contains a yellow pigment and no visual purple, while the retina in other parts has only the visual purple. This latter substance absorbs, and is bleached by, light of all parts of the spectrum, but in amounts varying with the wave-length, the absorption being very slight in the red and greatest in the yellowish green, which has the most rapid bleaching effect. The region of the spectrum which is most absorbed by the visual purple coincides with the elevation of the persistency curves. It was found that doubly fatiguing the green sensation with blue and yellow together causes green light to make a more luminous impression than it does normally. Several other unexpected results were obtained. In general we may conclude that the experiments described in this paper, which were carried out at Cornell University, strongly support the view that the fundamental colour sensations are red, green, and violet. A. R.

433. *Stereoscopy by Direct Vision.* **E. Estanave.** (Comptes Rendus, 148. pp. 224-226, Jan. 25, 1909.)—Take one negative by means of two lenses whose images coincide: interpose a ruled screen so that the black lines of this cut out linear strips of one image, while the linear spaces thus left are filled in by linear strips of the other image. The product is thus a single negative presenting linear strips belonging to the two images alternately. Reverse this before fixation so as to make a positive transparency. On assembling the screen, the positive and a piece of ground glass, in proper register and look-

ing through (screen towards the eye) a distance will be found at which each eye sees only its own component of the mixed positive, and the appearance is one of relief [see Abstracts Nos. 589 (1908) and 2018 (1906)]. The registration is, however, troublesome: and the author simplifies by making the black-and-clear ruled screen on one side of a glass plate, coating the other side with emulsion, taking the photograph through the glass, developing, reversing, fixing, and then coating with matt varnish. An autochrome plate may have a screen at the back of its glass (before being coated with its starch and emulsion) with similar effect in colours. A. D.

434. *Photography: Absorption and Photochemical Action.* **E. Lehmann.** (Zeitschr. Phys. Chem. 64. 1. pp. 89–119, Aug. 25, 1908.)—Historical *résumé.* Dry gelatine plates give no satisfactory results. Pure AgI, in all its modifications, gives maxima of absorption coincident with maxima of sensitiveness; the same with AgI in collodion. With excess of $AgNO_3$, as also in the case of pure AgI, there is a single sharp absorption band; with excess of KI there are two, weaker and blurred. In gelatine and gum emulsions AgI shows a shift ($=16\,\mu\mu$ in pure gelatine) between the two maxima, probably through the formation of an organic silver compound. The same results apply to the maxima in material stained with sensitisers. A. D.

435. *Photographic Latent Image.* **A. P. H. Trivelli.** (Zeitschr. Wiss. Phot. 6. pp. 438–442, Dec., 1908.)—Pressure on a dry plate induces developability; light can undo this effect; but pressure cannot annul the developability induced by light. Continued pressure does not induce anything analogous to solarisation. α-Silver sub-bromide is very insensitive to pressure. Methods are described of making in quantity the sub-bromides of silver identical with the material of the latent image. A. D.

436. *Animated Photographs in Natural Colours: Two-colour Method.* **G. A. Smith.** (Soc. Arts, Journ. 57. pp. 70–75; Discussion, pp. 75–76, Dec. 11, 1908.)—Cinematograph films exposed alternately through a pair of filters. Film sensitised far down into the red. Filters pass (1) yellow to red, (2) yellow to violet; exposures 16 through each filter per sec. In action, an equal synchronised alternation of coloured lights is passed through the respective alternating records; by the persistence of vision the alternating results on the screen are blended by the eye of the observer. The colours of the alternating flashes from the lantern are balanced so that they blend to produce an acceptable white, which may be somewhat yellowish without detriment to the result. The results on this two-colour method are satisfactory. A. D.

437. *Stellar Photography with Coloured Screens.* **Œsten Bergstrand.** (Comptes Rendus, 147. pp. 1463–1466, Dec. 28, 1908.)—After referring to the experiments of Wallace [Abstract No. 807 (1908)] on obtaining increased sharpness of the photographed star images by employing isochromatic plates with a suitably chosen colour screen, the author describes a series of exposures made at Meudon with the large telescope of 1 m. aperture and 8 m. focal length, using a yellow screen passing only light of wave-length about 5,500. The light passed by the objective was diffracted by an adjustable grill with bands and spaces each about 1·5 mm. wide, and stars of various colours were photographed on plates of ordinary type and also those made isochromatic. The exposure times varied from 8 to 8,160 sec. The effective lengths of spectrum were then measured from the resulting spectrograms of each star, and it appears that these vary with the star colour and length of exposure—from λ4120 to λ4490 for ordinary plates, and from λ4200 to λ4810 for orthochromatic plates without screen. It thus appears that the effects of atmospheric dispersion are also nullified by the use of a screen, and it is recommended for all purposes where precision is required, such as photographs taken for determining stellar parallaxes. C. P. B.

438. *Regulation of the Ray in Photographic Objectives.* **E. Wandersleb.** (Photographic Journ. 49. pp. 4–26, Jan., 1909.)—Geometrical optics is divided into three large branches, the purely geometrical theory of reproduction, the theory of aberration, and the doctrine of the regulation of the rays. In this last field a few occasional special questions have been dealt with at intervals by Petzval, Grubb, and Helmholtz; Abbe dealt with the problem in its most general form and gave it its most complete solution. The effect of a lens system, such as the Petzval objective, on the rays which fall on it is made out by means of the entrance pupil and the exit pupil. The entrance pupil is the virtual image of the diaphragm which the lenses of the system lying in front of the diaphragm project from it, and the exit pupil is defined in a similar way with reference to the lenses of the system lying behind the diaphragm. It follows that the exit pupil is the virtual image of the entrance pupil as projected by the system as a whole. The details of construction of the objective are then left out of the question, and it is assumed that, besides the principal and focal points, the entrance and exit pupils are known. The relative rapidity of different objectives is then shown to be, for infinitely distant objects, measured by the "relative aperture" of the system, or D/f where D is the diam. of the entrance pupil and f the focal length of the system. The depth of definition of the objective is also expressed in terms of the diam. of the entrance pupil. The second important characteristic of the lens system derived from the doctrine of regulation is the entrance "Luke" (or window), the name given to the real or virtual opening which regulates the principal rays in their entrance into the system whilst their direction is as yet unaltered by refraction in the lenses; principal rays are defined as those pencils producing images, which before their entrance into the system are directed towards the centre of the entrance pupil. These two apertures, used in conjunction, determine the range of points in the object plane which send any rays at all through the system, and they may also be used in determining the vignetting effect of the objective. G. E. A.

439. *New Method for measuring the Index of Refraction of a Gas for Different Light-waves.* **H. C. Rentschler.** (Astrophys. Journ. 28. pp. 345–359, Dec., 1908.)—A new method was used for measuring the values of μ for different gases. A Fabry and Perot interferometer was mounted in a brass tube closed at each end with quartz plates, and connected to a mercury pump so that it could be exhausted. Rays from a mercury arc lamp were passed in a parallel beam through the apparatus, and then they fell upon a concave grating. The sets of concentric circles for the various Hg lines were thus separated and could be photographed. The order of interference at the centre of each system of circles is some whole number x and a small fraction a. Three sets of photographs are taken at pressures of 1 atmo., 1/7 atmo., and zero pressure respectively, and from these the values of μ are readily found. If x' and a' be the differences in the values of x and a for atmo-

spheric and zero pressures, and if x'' and a'' similarly be the differences in x and a for 1/7 atmospheric and zero pressures, then clearly $x'' + a'' = (x' + a')/7$. While the values of a can be accurately read on each photograph those of x are unknown, so that x' is roughly determined for some line in the visible spectrum by counting the number of circles that form at the centre and spread out as the gas is slowly entering the tube. By trying different numbers for x' in the above equation that one which gives the experimental value of a'' is determined. The indices of refraction for air, O_2, N_2, CO, CO_2, were determined at $\lambda = 5769, 5460, 4358, 4046, 3650, 3341$, and the following dispersion formulæ obtained :—

Air .... $(\mu - 1)10^7 = 2908{\cdot}1 + 3{\cdot}80\ \lambda^{-2} + 1{\cdot}28\ \lambda^{-4}$
N_2 .... $(\mu - 1)10^7 = 2941 + 3{\cdot}81\ \lambda^{-2} + 1{\cdot}21\ \lambda^{-4}$
O_2 .... $(\mu - 1)10^7 = 2697{\cdot}4 + 3{\cdot}72\ \lambda^{-2} + 1{\cdot}26\ \lambda^{-4}$
CO .... $(\mu - 1)10^7 = 3241{\cdot}2 + 17{\cdot}01\ \lambda^{-2} + 0{\cdot}58\ \lambda^{-4}$
CO_2.................. $(\mu - 1)10^7 = 4490{\cdot}4 - 16{\cdot}55\ \lambda^{-2} + 4{\cdot}08\ \lambda^{-4}$.

E. C. C. B.

440. *Reflecting Power of Ethyl Alcohol.* **H. Rubens** and **E. Ladenburg.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 52. pp. 1140–1143, 1908.)—In a previous paper the authors described the reflecting power of ethyl alcohol [see Abstract No. 912 (1908)] between the limits of 1 μ and 18 μ. In the present paper they give the absorption curve of alcohol between the same limits and also a new curve for the reflecting power at an average temperature of —20°. A comparison of the present curve of reflecting power with the previous one shows two slight differences at about 2 μ, but otherwise the curves are very similar.

E. C. C. B.

441. *Refraction and Dispersion of Krypton and Xenon and their Relation to those of Argon and Helium.* **C. Cuthbertson** and **Mrs. M. Cuthbertson.** (Roy. Soc., Proc. Ser. A. 81. pp. 440–448, Dec. 22, 1908.)—Measurements of the refractivities and the dispersion of Kr and Xe between the limits $\lambda = 6500$ and $\lambda = 5000$. A comparison of the relative refractivities for infinite wave-length of the inert gases shows that for He, Ne, A, Kr, and Xe they are very accurately in the proportion 1 : 2 : 8 : 12 : 20. If the values found be expressed in the form $\mu - 1 = a(1 + b/\lambda^2)$, then b is a linear function of $\mu - 1$ for infinite wave-lengths. Sufficient evidence is not yet to hand to enable it to be determined whether the same relation holds for the other groups of the periodic table.

E. C. C. B.

442. *Scattering Action of Light and Optical Sensitisation.* **J. Stark.** (Phys. Zeitschr. 9. pp. 894–900, Dec. 15, 1908.)—The author deals first with the theory of the scattering action of light, and shows that the absorption of light can be accompanied by the emission of positive or neutral atomic rays, according to whether the light is absorbed by series lines or bands—that is to say, whether the electrons (negative ring-electrons) producing series lines are the resonators or the electrons (valency-electrons) producing band-spectra. He describes an experiment which tends to prove that under the influence of ultra-violet light gold emits neutral atomic rays. Following on this the author deals with optical sensitisation, that is, the catalysis of reactions between non-absorbing gases by the admixture of some gas which does absorb light.

E. C. C. B.

443. *Optical Properties of Films of Magnetic Metals.* **C. A. Skinner and A. Q. Tool.** (Phil. Mag. 16. pp. 833–862, Dec., 1908. Paper read before the Amer. Physical Soc., Chicago, Jan., 1908.)—A study of the magnetic rotation and ellipticity produced in plane-polarised light by films of iron, nickel, and cobalt, and of the refractive indices and extinction coefficients of these films. By varying the methods of producing the films, viz., by kathodic and electrolytic deposition, three distinct types, designated dark, electrolytic, and metallic, have been obtained, one of which exhibits a marked absorption region in the visible spectrum, whilst the other two seem to have the centre of such a region well out in the ultra-violet. The types differ essentially in the period of their optical resonance and in the magnitude of their optical extinction. The extinction coefficients of both electrolytic and metallic films are greatly in excess of those obtained by other observers, and existing theories do not appear to lend themselves to explain the results obtained. G. E. A.

444. *Rotatory Power of Quartz at Temperature of Liquid Air.* **F. A. Molby.** (Phys. Rev. 28. pp. 57–68, Jan., 1909.)—The optical rotatory power of right-handed and left-handed quartz is measured at temperatures ranging from —20° to —190° C., and is found to vary between 21·693° per mm. at 20·8° C. and 21·196° per mm. at —190° C. At low temperatures the curve of rotatory power shows a tendency to become parallel to the axis of temperatures. [See also Abstract No. 229 (1909).] G. E. A.

445. *An Extension of the Principal Series of the Sodium Spectrum.* **R. W. Wood.** (Phil. Mag. 16. pp. 945–947, Dec., 1908.)—The principal series of sodium has been extended by observing the absorption of sodium vapour, using the Cd spark as the light-source. Thirty lines were recognised, but the wave-lengths of the last six could not be determined with the apparatus used. The wave-lengths of the remainder, correct to within 0·2 Å.U., are given in the paper. E. C. C. B.

446. *Anomalies in the Intensity in Diffracted Spectra.* **H. C. Pocklington.** (Roy. Soc., Proc. Ser. A. 81. pp. 435–489, Dec. 22, 1908.)—Wood has found that the spectra of an incandescent lamp formed by a grating can have bright and dark lines in them which occur at the same place in each order of spectrum and move through the spectrum when the inclination of the grating is altered. This phenomenon has been investigated by Rayleigh [see Abstract No. 1682 (1907)], who dealt with diffraction by a grooved surface, but owing to analytical difficulties used approximations. In the present paper the author gives an accurate investigation of a theoretical grating. E. C. C. B.

447. *Calcium Spectrum in Electric Furnace.* **A. S. King.** (Astrophys. Journ. 28. pp. 389–396, Dec., 1908.)—Series of photographs of the spectrum of calcium were taken at different temperatures by means of a powerful electric furnace, with the object of investigating the relative behaviour of the blue line (λ4227) and violet lines H and K. Previous work by Huggins using the electric spark has suggested that the chief cause governing these appearances is the density of the calcium vapour, 4227 appearing when a large quantity of vapour is producing the radiation, while with gradually decreasing quantities this reduces more rapidly than H and K, and finally these two lines show without the blue line. In low-temperature flames 4227 is alone present. In the present paper photographs are given showing the furnace- and arc-spectra at different temperatures and with varying amounts of calcium vapour. The line λ4227 appears easily in the furnace spectrum and increases with the quantity of vapour. H and K appear only as very fine lines in the furnace spectrum, and are reversed only with difficulty. It is thus indicated that these violet lines are indicative of high temperature, although the vapour density may also have an important effect. [See also Abstract No. 1414 (1908).] C. P. B.

448. *Dispersion of Water in the Infra-red Spectrum.* **H. Rubens** and **E. Ladenburg.** (Deutsch. Phys. Gesell., Verh. 11. 1. pp. 16–27, Jan. 15, 1909.)—The authors have repeated their previous measurements of the reflecting power of water [Abstract No. 912 (1908)], using more sensitive apparatus, and have also determined the absorption by using a soap film of constant thickness. The values agree well with those of Aschkinass. Tables are also given of the index of refraction between $\lambda = 1\,\mu$ and $\lambda = 18\,\mu$ for water at 18°, and there is added the dispersion curve between $\lambda = 1\,\mu$ and $\lambda = 7\,\mu$. E. C. C. B.

449. *Further Remarks upon the Thermal and Chemical Absorption in the Band Spectrum.* **J. Stark.** (Phys. Zeitschr. 9. pp. 889–894, Dec. 15, 1908.)—The author extends the views put forward in his previous papers [see Abstracts Nos. 1087 and 1642 (1908)] and deals in particular with primary photochemical reactions, for which he enunciates three laws: First, that these reactions are monomolecular; second, that (at any rate, at $\lambda = 4500$) they are independent of the temperature; and, third, that the amount of the product of the reaction formed in unit time is proportional to the amount of the active light. E. C. C. B.

450. *Magnetic Rotatory Power of Calcium Fluoride Vapour and of Nitrogen Peroxide in the Neighbourhood of their Absorption Bands.* **A. Dufour.** (Comptes Rendus, 147. pp. 1471–1472, Dec. 28, 1908.)—The author finds that CaF_2 vapour shows anomalous Zeeman-effects; of the three bands $\lambda = 6037$, $\lambda = 6051$, $\lambda = 6064$, the first two give anomalous results, while the third is normal. The anomaly consists in the fact that the magnetic rotation is negative outside the longitudinal Zeeman doublet and positive between the two components of the doublet. The same anomaly is also to be noted in the case of the lines $\lambda = 5925$ and $\lambda = 5857$ of NO_2, while the neighbouring lines $\lambda = 5855$ and $\lambda = 5847$ are quite normal. E. C. C. B.

451. *Measurement of Rotatory Dispersion Power in the Visible and Ultra-violet Regions of the Spectrum.* **T. M. Lowry.** (Roy. Soc., Proc. Ser. A. 81. pp. 472–474, Dec. 31, 1908. Chem. News, 99. p. 13, Jan. 8, 1909. Abstract.)—A preliminary account of an apparatus for determining rotatory dispersive power throughout the whole spectrum. A parallel beam from an arc is thrown on to the widely opened slit of a constant-deviation spectroscope and an achromatic lens of 22 in. focus is substituted for the observing telescope of the instrument; this lens throws a magnified image of the slit upon the polarising prisms which produce the horizontally divided triple field of the polarimeter. By using a constant-deviation prism of high density a very brilliant band of monochromatic light can be obtained. In order to eliminate stray light a Perkin spectroscopic eyepiece is used. For the ultra-violet a parallel beam of light from a carbon-magnetite arc is cast directly by a quartz lens on to the triple field of the polariser, Foucault prisms being substituted for the nicol prisms. A quartz-calcite lens of 18-in. focus is substituted for the analyser telescope, and this casts a diminished image of the triple field on the slit of an ultra-violet spectroscope. The spectrum thus produced is photographed in the ordinary way. By taking photographs with the analyser in different positions it is possible to determine the rotatory power of a substance throughout the transmitted spectrum. The values are given for methyl camphocarboxylate between $\lambda = 6708$ and $\lambda = 4859$. E. C. C. B.

452. *Zeeman-effect in Weak Magnetic Fields.* **H. Nagaoka** and **S. Amano.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. No. 21. pp. 421–426, Nov., 1908. Nature, 79. p. 221, Dec. 24, 1908.)—Voigt has pointed out that the displacement of the outer components of the Zeeman triplet plotted against the strength of the magnetic field is represented by a hyperbola, when the line is observed at right angles to the field. The hyperbola approaches asymptotically to a straight line in strong fields where most of the previous observations have been made. Moreover, the intensity of the red component is greater than the violet one in weak fields and gradually tends to equality as the field is increased. The author has examined the lines Au $\lambda = 6276$ and $\lambda = 5885$ which by properly adjusting the self-inductance and capacity of the circuit can be made quite sharp. The Voigt-effect can be observed on the red line triplet in a field of 240 gauss, and on following the curve to strong fields it is approximately represented by a branch of hyperbola with very short axis, showing a slight bend in $H = 8{,}000$, which is probably caused by the asymmetry in the intensity of the component lines. A similar result is obtained with Cu $\lambda = 5105$. With the quartet of the yellow Au line the nature of the change of the inner components is similar to the above triplet, but the curvature is more pronounced. The displacement of the outer components is more complex in weak fields but from $H = 5{,}000$ upwards it is approximately linear with the field. A similar effect is observed with the Mg line b_1. E. C. C. B.

453. *The Law of Shift of Central Component of a Triplet in a Magnetic Field.* **P. Zeeman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 473–477, Jan. 27, 1909.)—An accurate series of measurements of the shift of the central line of the magnetic triplet of Hg $\lambda = 5791$ made by means of a 5-mm. and a 25-mm. Fabry and Perot étalons. The values obtained show, as pointed out by Gmelin, that the shift in wave-length from the undisturbed position is proportional to the square of the magnetic force. [See Abstracts Nos. 784, 1109 and 1110 (1908).] E. C. C. B.

454. *A Method of showing Fluorescent Absorption directly, if it exists.* **R. W. Wood.** (Phil. Mag. 16. pp. 940–944, Dec., 1908.)—It has been stated by Nichols and Merritt and by Miss Wick that the absorption by a fluorescent medium is greater when the fluorescence is excited by a transverse light-beam than when fluorescence is not so excited. [See Abstracts Nos. 2554 (1904) and 1164 (1907).] This, however, has been denied by Camichel [Abstract No. 1002 (1905)]. The author has investigated the phenomenon with a new type of apparatus, and is unable to find any such influence by the exciting light. Two images of an arc are focussed upon a rapidly revolving perforated disc, and by means of a lever the images can be thrown in or out of step with the perforations at will. The rays from one lens pass on through a tank of fluorescein solution into a spectrophotometer, while the rays from the other lens are reflected so that they cross the fluorescein solution transversely. It is evident that if the absorption were increased by fluorescence the light would be decreased in the spectrophotometer when the two images were in step. No such effect was observed. E. C. C. B.

455. *Triboluminescence.* **D. Gernez.** (Annal. Chim. Phys. 15. pp. 516–556, Dec., 1908.)—The author gives a *résumé* of work on this subject [see Abstracts Nos. 1571, 1574 (1905); Comptes Rendus, 147. pp. 11–15, 1908; Guinchant, Abstract No. 1572 (1905)], the substances dealt with being arsenious oxide, potassium sulphate and a large number of other salts of organic and inorganic acids, metallic and organic racemates. Tschugaeff's statement that a number of optically active compounds exhibit triboluminescence, whilst a racemic compound composed of two triboluminescent constituents does not [Abstract No. 985 (1905)], is inaccurate, since *d*-, *l*-, and *r*-erythritols all show triboluminescence. T. H. P.

456. "*Metal-rays.*" **E. B. Andersen.** (Phys. Zeitschr. 10. pp. 54–57, Jan. 15, 1909.)—Photographic plates are differently sensitive to "metal-rays"; Lumière insensitive; Agfa sensitive. The most electropositive metals produce the greatest effect (Mg, Al, Zn, Cd), but only from polished surfaces; electronegative metals only from matt surfaces. Carbon in a film on Zn or Mg increases the effect; carbon by itself has none. The result is associated with oxidation, which is accelerated by galvanic action of a film of carbon on the metal; and it shows a diffuse radiation of very feeble penetrating power, capable of reflection and of converting oxygen into ozone. There is no action unless there be oxygen present. The ozone produced sinks under the action of gravity, and where it falls produces chemical effect: and similarly at the points which it reaches by diffusion. A. D.

457. *Röntgen Rays: Emission and Transmission.* **G. W. C. Kaye.** (Roy. Soc., Phil. Trans. Ser. A. 209. pp. 123–151, Nov. 19, 1908.)—Rays from some twenty elements are examined. Relative intensities (ionisation method of measurement) of rays through an Al window do not follow the atomic weights of the antikathodes, but indicate a grouping of the elements identical with that of Barkla and Sadler arrived at from secondary Röntgen rays. When screen and radiator are of the same metal there is a selective transmission; with hard Röntgen rays or γ-rays this becomes feeble or none. The selective transmission is most pronounced in the Cr-Zn group, and is least marked with low atomic weights. The lower the atomic weight of a metal in a group, the softer the radiation for which it shows special transparency. With Al screens of increasing thickness, a thickness is reached at which all radiations come to the same quality or hardness; so that further increases in the thickness do not alter the relative values of the radiations transmitted. These relative values are approximately proportional to the atomic weights of the radiators, and, for the heavy-atomed metals, increase somewhat with a rise of potential on the tube. Benoist's transparency curve depends not only on the range and degree of absorption, but also on the material of the anti-kathode. Discussion follows of the anomalous behaviour of Ni in relation to its generally accepted atomic weight. The curve of transmission (thickness of screen against log. intensity) presents three portions when screen and radiator are of the same metal; (1) thin screen, steep portion; (2) medium, straight line, exponential absorption; (3) thick, slope gradually diminishes. The extent of (2) diminishes with a rise of potential on the tube. Stage (1) may be due to secondary radiation, stage (3) to scattering and the presence of hard rays. If the potential on the tube is not too high, stage (3) may be absent. When screen and radiator have remote atomic weights, stage (2), exponential absorption, does not appear, but (1) runs into (3). The terms hard and soft rays should be confined to comparisons with screens of the same metal. **A. D.**

458. *Generation of Heat by Radium.* **E. v. Schweidler** and **V. F. Hess.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 879–888, June, 1908. From the II. Physikal. Inst. d. k.k. Univ., Wien.)—The following table is given to show the results obtained, and methods adopted by previous observers, for estimating the quantity of heat given out by 1 gm. of the metal radium :—

Author.	Preparation.	Method.	Quantity of Heat, gm.-cals. per hour.
P. Curie and A. Laborde	1 gm. 17 per cent. bromide	—	100
Runge and J. Precht ...	—	—	105
E. Rutherford and H. T. Barnes	30 mgm. pure bromide	Differential air thermometer	110
J. Precht	34 „ „ „	Ice calorimeter	113·3
K. Ångström	90 „ „ „	Electrical compensation calorimeter	117
J. Precht	25 „ „ „	Ice calorimeter	134

The radium preparation used in the present experiments was 1·0523 gm. of radium-barium chloride, dried at 180° C. and containing 0·7951 gm. of metallic Ra, on the basis of the atomic weight of Ra = 226. The principle on which the quantity of heat generated is estimated is as follows : Two calorimeters having as nearly as possible equal capacities for heat are placed in a space which is kept at a constant temperature. One calorimeter is heated by radium, and the other by passing a known current through a heating spiral The current is so regulated that both calorimeters are kept at the same temperature. Details are then given as to the calorimeters used, the measuring of the temperature, and the arrangements for the current through the heating spiral, as well as the precautions taken to avoid errors due to heat from outside sources, &c., during the carrying out of the experiments. As the result it is found that the quantity of heat generated by 1 gm. of the metal radium in one hour is 118·0 gm.-cals. The probable error is estimated to be not more than 1·4 per cent. With reference to the rays used in these experiments it is remarked that only those rays are not used which could penetrate 1 mm. of glass and 5 mm. of copper. **A. E. G.**

459. *Velocity of Röntgen Rays.* **E. Marx.** (Ann. d. Physik, 28. 1. pp. 37–56, Dec. 28, 1908. Physikal. Inst., Leipzig, Oct., 1908.)—This paper contains a justification of the method used by the author for finding the velocity of the Röntgen rays [see Abstract No. 92 (1906)]. A small Röntgen tube is excited by Hertzian waves ; below this is a discharge tube in which is an electrode connected through a small condenser to a movable bridge. An altered phase is obtained by moving the Röntgen tube. The phase is indicated by the deflection of an electrometer. The displacement of the tube can be compensated by moving the bridge, since the phase depends on the distance of the bridge from the electrode. Then the time the wave needs to travel twice the distance the bridge is moved is known, and this is equal to the unknown time taken by the Röntgen rays to travel the distance the tube is moved. Tests of the experimental basis of the work are then stated, and these are followed by experimental proofs that only one meaning can be attached to the results obtained. In order that these experiments may succeed certain points must be carefully attended to, and then the following will also be noted. A displacement of the bridge of about 2 mm. is sufficient to destroy the null. The position of the null point on the bridge-wires is independent of the intensity of the rays over a relatively wide range. When the pressure of the receiving tube is too low a negative deflection is obtained for every position of the bridge, while a positive deflection takes place if the pressure is too high. No constancy of the null point can be obtained except for a constant ratio between the air pressures of the two tubes; higher pressure in the receiver requires harder rays. The positive deflection of the electrometer is so slight as to require a very sensitive electrometer, on the other hand, the negative deflection is very large; with the largest deflections a quite perceptible lighting of the gas takes place if the room is darkened, but this never occurs with a positive deflection, nor at the null. The theoretical explanation of these observations is given in detail, as is also that of other properties of the Röntgen rays which enter into consideration in these experiments, such as the direct ionisation which takes place in the gas, and the surface effects at the glass walls of the tubes and at the electrodes. [See also Abstracts Nos. 786, 787 (1908).] A. E. G.

460. *Absorption of Radium Emanation by Cocoanut Charcoal.* **E. Rutherford.** (Manchester Lit. and Phil. Soc., Mem. 53. 2. pp. 1–2, Dec. 31, 1908.)—Attention has been previously called by the author to the fact that the emanations of radium, thorium, and actinium are completely absorbed by cocoanut charcoal at ordinary temperatures [see Abstract No. 64 (1907)]. In the present paper an experiment is described in which it is found, when working with larger quantities of RaEm, that the actual volume which the charcoal will absorb at the temperature of the room is very small. The absorptive power of the charcoal, however, rapidly increases as the temperature is lowered. Thus at 10° C. charcoal absorbs about 0·03 mm.^{3} of the emanation per gm., and at —40° C. about 0·06 mm.^{3} per gm. Practically all the emanation is released at a temperature of the softening of glass. A. E. G.

461. *Radiation of the Active Deposit from Radium.* **S. Russ** and **W. Makower.** (Nature, 79. p. 340, Jan. 21, 1909.)—When α-particles are emitted from the radium emanation leaving RaA, the former travel with a velocity of $1{\cdot}70 \times 10^9$ cm./sec.; the particles of the latter must recoil in a direction opposite to that of the α-particles with a speed of about 10^7 cm./sec. and they should thus constitute a type of very easily absorbed radiation. The effects of this radiation have been observed by exposing to it a plate placed in a vacuum. The activity of the side of the plate turned towards the emanation became much greater than that of the side turned away from it. J. J. S.

462. *α-Rays from Radium B.* **F. A. Harvey.** (Phys. Zeitschr. 10. pp. 46–48, Jan. 15, 1909. From the English.)—The author here describes experiments on the α-rays from radium B, and shows that the rays in air under normal conditions penetrate a distance of 2·6 to 3 mm. The method employed in the experiments was a modification of that of Bragg and Kleeman [Abstract No. 2061 (1905)]. The latter part of the paper deals with atmospheric radio-activity, experiments being made with an exposed wire, negatively charged by means of a Wimshurst machine. The effect of alteration of the barometric pressure is considered, and the author shows that with a quickly falling barometer there is an increase in the amount of induced thorium activity. A. W.

463. *Nature of the α-Particle.* **E. Rutherford** and **T. Royds.** (Manchester Lit. and Phil. Soc., Mem. 53. 1. pp. 1–8, Dec. 31, 1908. Chem. News, 99. p. 49, Jan. 29, 1909.)—Previous researches of Rutherford and Geiger indicate that the α-particle from radio-active substances is an atom of helium carrying a positive charge [see Abstracts Nos. 1627, 1628 (1908)], and Dewar has furnished additional evidence of the same by his measurements of the rate at which helium is produced [Abstract 1808 (1908)]. This evidence is, however, of too indirect a character to prove conclusively that the α-particle becomes an atom of helium when it loses its charge. It might be possible, for example, that the expulsion of an α-particle led to the liberation of He from the active matter, but that the α-particle itself was not an atom of He. It must be shown that He can be obtained from accumulated α-particles, quite independently of the active matter from which they are expelled. The method of doing this is described. Purified emanation corresponding to the equilibrium amount from 150 mgm. of radium is compressed into a fine glass tube about 1·5 cm. long. The walls of this tube are strong enough to withstand atmospheric pressure, but thin enough to allow the α-particles to escape into a surrounding glass tube about 8 cm. long and 1·5 cm. in diam. which is completely exhausted. A side tube is so arranged that the gases collected in this outer tube can be compressed into a vacuum tube and their spectra examined. Twenty-four hours after the introduction of the emanation no trace of He could be detected, at the end of 2 days the He yellow line was faintly seen, after 4 days the yellow and green lines came out brightly, and after 6 days the whole of the He spectrum was visible. A check experiment, in which the emanation was replaced by about 10 times its volume of He, proved that the He in the outer vessel had not diffused from the emanation through the thin walls of the tube; for no trace of He was observed in the outer tube over a period of 8 days. This experiment, therefore, proves conclusively that the α-particle after losing its positive charge is an atom of helium. Other evidence indicates that the positive charge is twice that carried by the hydrogen atom. A. E. G.

464. *Nature of α-Particles from Radio-active Substances.* **E. Rutherford** and **T. Royds.** (Phil. Mag. 17. pp. 281–286, Feb., 1909.)—Experiments are described to test whether helium appears in a vessel into which α-particles have been fired [see preceding Abstract]. A diagram illustrating the apparatus used is given. Helium is not present in sufficient quantity for the spectrum to show the yellow line until after two days, whilst the amount produced in one day should be sufficient to give a bright spectrum of He. It therefore appears that He fired into the glass escapes only very slowly into exhausted space. When a thin sheet of lead is placed over the thin emanation tube so as to stop the α-particles, the spectrum of He is of about the same intensity after one day as it was after the fourth day when working without the lead screen. Thus lead-foil gives up the He fired into it more readily than the glass. Another experiment is tried to test the rapidity of escape of the He from the lead. It is found possible to detect the presence of He in the lead which has only been exposed 4 hours to the α-rays from the emanation; whilst after 24 hours the yellow and green lines come out brightly. Tin-foil is also used in a similar manner with like results. Hence it appears that He does not escape from the lead at once, but suffers a retardation of several hours. Also, since He is found in the lead and tin-foil, it removes the objection that He might have been present in the glass initially, and was liberated during the α-ray bombardment. A. E. G.

465. *Secondary Ionisation due to β-Rays.* **W. H. Bragg** and **J. P. V. Madsen.** (Roy. Soc. of South Australia, Proc. Vol. 31. 1907. Phil. Mag. 16. pp. 692–697, Oct., 1908.)—Unless an ionisation chamber be used so large that even the fastest β-particles spent their ionising power within it (assuming that the whole ionisation produced by a β-particle is a measure of its energy), the ionisation-chamber method of measuring the amount or the energy of the rays gives an unfair advantage to the particles of smaller velocity. The secondary radiations given off by different substances struck by the same primary stream are softer (less penetrating) the lower the atomic weight of the substance struck. If we interpose in the path of the rays in an ionisation-chamber an absorbent film, we imitate the absorption in air in a larger ionisation-chamber; and then the curve connecting secondary ionisation with atomic weight becomes almost linear. The secondary radiation from different substances, due to the β- and γ-rays of radium, varies in quality, those of lower atomic weight returning a greater proportion of the penetrating rays; and when the less penetrating portion of a primary beam of β-rays from radium is sorted out, the secondary rays also become more penetrating. A. D.

466. *Number and Absorption by Matter of the β-Particles emitted by Radium.* **W. Makower.** (Phil. Mag. 17. pp. 171–180, Jan., 1909.)—The author has investigated the absorption of the β-rays by glass and finds that the absorption curve does not differ appreciably from that for Al [see Schmidt, Abstract No. 67 (1907)], as would be expected from the similarity of density of these two substances. It is found that, when the β-rays are absorbed by glass, the charge carried by the particles which are absorbed remains in the glass, indicating that the rays are actually stopped by the glass and not merely scattered. The number of β-particles emitted by RaC in radio-active equilibrium with 1 gm. of radium is $5{\cdot}0 \times 10^{10}$. T. H. P.

467. *Absorption of Different Types of β-Rays.* **V. E. Pound.** (Phil. Mag. 17. pp. 126–153, Jan., 1909. Paper read before the Roy. Soc. of Canada, May 16, 1908.)—This paper deals with the absorption of the different types of β-rays, and studies the secondary rays excited by the different types. The author criticises Mackenzie's work on β-rays [Abstract No. 1522 (1907)], saying that it was possible that in cutting off the β-rays in order to study the effect of the γ-radiation alone he also cut off a greater proportion of the latter than he estimated. If this were so it would result in ascribing to the β-radiation a part of the secondary radiation which properly should have been ascribed to the γ-rays. In view of the importance of Mackenzie's results in their relation to theories of secondary radiation now being put forward by Bragg [see Abstract No. 1445 (1908)] and others, the author has made a more extended examination of the secondary radiations excited by both β- and γ-rays; in differentiating the effects due to the various types of rays, the action of each was ascertained by deflecting pencils of each type into an ionisation-chamber

away from the others by means of a magnetic field. The arrangement of the apparatus used was as follows: The receptacle for holding the radium was a lead cylinder with walls 4 cm. thick. One end of the cylinder was covered by a brass plate 2·5 mm. thick, in the centre of which was a hole 4·5 mm. in diam. The radium radiation passed out through the hole and between the poles of a powerful electromagnet, immediately beneath which was the ionisation-chamber, also made of lead, and provided with a properly screened and insulated electrode connected to a Dolezalek electrometer, by means of which saturation currents were measured. At the top and bottom of the chamber were brass rings to hold different thicknesses of selected absorbing materials. The results of the different series of experiments are tabulated and curves plotted, for which see original paper. The results may be summarised thus: (1) The β-radiation from radium bromide, which includes the β-radiations from all the radium products in the equilibrium state, will not produce any ionisation on the far side of a plate of Al 7 mm. in thickness, of a plate of tin 2·5 mm. in thickness, or of a plate of lead 0·9 mm. in thickness. (2) The max. secondary radiation emitted from the front side of plates of the metals Al, Sn, and Pb, when bombarded by β-rays, are given by the following thicknesses: Al, 0·4 mm.; Sn, 0·24 mm.; Pb, 0·16 mm. (3) The transmitted secondary radiations excited by γ-rays in lead and tin are more penetrating than the transmitted secondary radiation excited in Al by the same rays. (4) When β-rays are allowed to fall in turn on reflectors of different metals it is found that the greater the density of the metal from which the reflector is made the greater is the penetrability of the reflected secondary rays excited by the β-radiation. (5) From the experiments on the transmission of β-rays through sheets of Al-foil it has been shown that when very thin sheets of the metal are used the ionisation at first contributed by the transmitted secondary radiation excited by the β-rays is greater than that lost through absorption of the primary rays. A. W.

468. *Absorption of β-Rays by Liquids.* **N. Campbell.** (Phil. Mag. 17. pp. 180–190, Jan., 1909.)—In some experiments on the absorption of β-rays from potassium by solutions of potassium salts the author found that λ/ρ for the solution might be greater than either of those for the solute or the solvent. The present experiments were undertaken in order to discover whether the abnormality arises from the rays or the solutions. The apparatus made use of is the same in principle as that used by Crowther, except that, owing to the difficulty of obtaining layers of liquid which shall be of uniform thickness, and yet thin enough to be penetrated by a measurable quantity of the rays, the liquids used are absorbed in a thick sheet of filter-paper, and this paper placed on a carefully levelled tray. The source of the β-rays is 50 gm. of uranium oxide. From preliminary experiments it appears probable that the "absorption curve" for solutions is not accurately exponential, and detailed investigation is next made on this point. The apparatus is first tested for solids, and results show no evidence of any deviation from the accepted law. When water poured on the filter-paper is tried irregularities at once appear, and no change in the apparatus has any effect on the shape of the absorption curve obtained. Other liquids, such as paraffin, aniline, alcohol, as well as several solutions, all show similar peculiarities. Curves for water with and without the filter-paper are given. In all cases the absorption coefficient is less when using filter-paper than when it is not used. The absorption due to aqueous solutions of NaI, KNO_3, K_2CO_3, and an alcoholic solution of NaI is next tested. The results are so different for different substances that no

general conclusions can be drawn. Curves are given for these. It, however, seems very doubtful with regard to the absorption of β-rays of uranium whether liquids possess a true absorption coefficient (λ) as defined by the equation $I = I_0 e^{-\lambda x}$. A further experiment is tried to ascertain whether the same mass of substance possesses the same absorption in the solid and liquid states. For this purpose water and paraffin wax are used. The measurements are not reliable owing to temperature changes, but no certain change in the current is noted when the substances change from solid to liquid, or *vice versâ*. It is not pretended that the experiments are in any way final, except in so far as the comparison between the abnormal absorption of potassium rays and β-rays from uranium by solutions is concerned. A. E. G.

469. *The Nature of γ-Rays.* **W. H. Bragg** and **J. P. V. Madsen.** (Phil. Mag. 16. pp. 918–939, Dec., 1908. Roy. Soc. of South Australia, Proc. Vol. 32. 1908.)—This paper is an account of a continuation of previous experiments [Abstract No. 1445 (1908)]. A more thorough investigation of the nature and amount of emergence radiation has been made. A normal stream of γ-rays always contains β-rays, and if these are stopped by a screen fresh β-rays emerge from the other side of the screen. A powerful magnetic field was therefore used to purify the γ-ray stream for a short distance along its path. The radium was placed at the bottom of a conical hole made in a massive block of lead. Plugs of various materials and different thicknesses were turned to fit exactly in the hole. The path of the rays passed between the poles of a magnet and through a screen before entering the ionisation chamber, and in some cases impinged on a reflector or Al-foil beyond the chamber. By measurements of the current by means of a Dolezalek electrometer a comparison of the emergence and incidence radiations was made. A large want of symmetry between the radiations on the two sides of a plate was shown. The results attained by the authors are as follows: (1) When γ-radiation is diminished in quantity in consequence of its passage through matter, β-radiation appears in its place, moving at the outset in the original direction of the γ-radiation and subsequently undergoing scattering in the ordinary manner of β-rays. (2) The speed and penetration of the β-radiation thus produced increase with the penetration of the γ-radiation to which it is due. (3) The speed of the β-radiation does not depend on the nature or condition of the atom in which it arises. (4) In the case of radium the speed of the β-radiation produced is nearly equal to the speed of the β-rays emitted by radium itself. (5) When very hard γ-rays traverse matter the absorption and the consequent production of β-rays are almost independent of the atomic structure of the matter, and a density law follows. Softer rays are affected by the atomic structure, in that the heavier atoms are more absorbent than the lighter, weight for weight, and the softer the rays are the more prominent this effect becomes. The support which these results afford to Bragg's neutral-pair hypothesis is discussed in the concluding portion of the paper. The authors point out that their experiments tend to confirm this hypothesis, according to which both the energy and the material of the secondary electron are derived from the primary ray. Cooksey's recent experiments indicate a parallelism between the behaviour of X- and γ-rays. [See also Abstract No. 69 (1909).] J. J. S.

470. *The Secondary Radiation excited by γ-Rays.* **F. E. Hackett.** (Roy. Dublin Soc., Trans. 9. 9. pp. 201–218, Jan., 1909.)—An account of the direct

measurement of the secondary radiation emitted from the upper surface of a plate, when γ-rays are incident on the lower surface, is given. The pencil of rays passes up through the plate at an angle of 45° to the normal. The intensity of the radiation emitted in the plane of incidence in a direction normal to the γ-rays is measured by means of an ionisation cylinder. The secondary radiation thus measured is nearly constant for all atomic weights ranging from 27 to 120, but increases for the Au-Pb-Bi group of elements, and there is a further increase for uranium. A discussion of these results leads to the conclusion that the secondary radiation per atom is roughly proportional to the atomic weight when this does not exceed 120, and increases more rapidly than the atomic weight for elements of high atomic weight such as Pb and Pt. It is shown that this result is in general agreement with the work of Kleeman on the relative ionisation of gases per atom by γ-rays, which also increases at the same rate as the atomic weight. The penetrating power of the secondary β-radiation diminishes with the increase of atomic weight for soft γ-rays, but increases with the atomic weight for hard γ-rays. For elements of low atomic weight, such as Al, the penetrating power of the secondary β-radiation does not alter with the penetrating power of the primary, but it increases with the latter for elements of high atomic weight. The results of this paper do not afford any decisive test between the ether-pulse theory and Bragg's theory. J. J. S.

471. *Radiation of Uranium-X.* **H. W. Schmidt.** (Phys. Zeitschr. 10. pp. 6–16, Jan. 1, 1909. Physikal. Inst. d. Univ., Giessen, Nov. 12, 1908.)—The author finds that uranium-X preparations having activity of specific intensity can be prepared by a combination of Becquerel's method of precipitating the UrX by means of barium sulphate with the method of Moore and Schlundt [Abstract No. 2106 (1906)]. By magnetic deviation experiments [see Abstract No. 1516 (1907)] the velocity of the hard β-rays from UrX is found to be $2{\cdot}76 \times 10^{10}$ cm./sec., whilst the relation of charge to mass, e/m, has the value $0{\cdot}67 \times 10^{7}$ electromagnetic units. The soft radiation from UrX is absorbed by Al according to an exponential law, and in the magnetic field, is deviated in the sense of the moved particles of negative electricity. The curves for the hard β-radiation after passing through matter are in high degree dependent on the experimental arrangement. The deviations from the exponential curve indicated theoretically when certain assumptions are made, are only partially explained by irregular distribution of the radiation in the matter traversed or by a possible slight diminution of the velocity of the β-particles as the length of path in the matter traversed is increased. The experiments give a lower limit for the absolute value of the β-radiation reflected by a very thick plate; with the hard β-radiation this absolute value is greater than with the soft. T. H. P.

472. *The Product and Rays of Uranium-X.* **F. Soddy.** (Nature, 79. pp. 366–367, Jan. 28, 1909.)—A discussion of the observations made in certain experiments still in progress. It has been found that there is a feeble residual α-radiation remaining from UrX preparations after the β-radiation has decayed, and this residual activity then remains constant. It still remains doubtful whether an intermediate body exists between UrX and the parent of radium. There is some evidence that the β-rays of UrX are not homogeneous. Some of the β-rays of radium appear to possess values for $H\rho$ above 9,000. J. J. S.

473. *New Radio-active Product in the Uranium Series.* **J. Danne.** (Comptes Rendus, 148. pp. 337–339, Feb. 8, 1909.)—In the process of preparation and concentration of the UrX contained in 20 kg. of nitrate of uranium, a new substance, the immediate parent of UrX has been discovered. It is proposed to name this substance radio-uranium. The principal reactions by which the concentration of UrX and the separation of the new product are brought about are the following: The uranium nitrate is dissolved in water, and most of the UrX is precipitated from this solution by means of barium sulphate; the sulphates so obtained are converted into carbonates, these carbonates dissolved in hydrochloric acid, and the usual analytical separations made. The hydrates obtained by this separation contain a small quantity of iron, a larger quantity of Ur, and the greatest part of UrX. These hydrates are converted into nitrates, then Ur is separated from UrX by means of acetone, the UrX not being soluble in that compound. The insoluble nitrates are thoroughly washed with acetone to remove all traces of Ur, then dissolved in water, evaporated to dryness and calcined; next subjected to the action of warm water to which a small quantity of HCl is added. The UrX remains undissolved, but a product B is obtained by evaporating the solution to dryness, which is found to increase in activity if kept. This is found to be due to the formation of UrX. This product B is dried at 150° C., treated with warm water; the insoluble part B_1 is chiefly oxide of iron: the solution is shaken up with fresh ferric hydrate and the precipitate B_2 is washed and dried; the remaining liquid is evaporated to dryness and yields a product B_3. B_1 and B_2 have an activity which decreases with time, while the activity of B_3 increases in such a manner that in 44 days its activity is considerably more than doubled. This is due to the radio-uranium which it contains. According to these results this new substance comes between Ur and UrX. Its presence in this place enables explanation to be given of certain peculiarities observed in the case of the salts of uranium. A. E. G.

474. *New Phenomenon in the Radio-activity with Actinium.* **O. Hahn.** (Phys. Zeitschr. 10. pp. 81–88, Feb. 1, 1909. Chem. Inst. d. Univ., Berlin.)—The active deposit of actinium has been shown to consist of three quickly decaying products, A, B, and C [see Abstract No. 1961 (1908)]. Several observers have noted a very small slowly decaying residual activity, the nature of which has not been explained. Thus St. Meyer and E. v. Schweidler have found its strength to be about 1/10000 of the original activity of the active deposit, and its period to be about 11·8 days. The present paper contains a detailed account of experiments made to investigate this question, and the principal results obtained are as follows: (1) Under suitable conditions one obtains with actinium preparations, along with the active matter on the negative electrode, a small residual activity besides the active deposit. The quantity of this depends essentially on external conditions, but by applying a negative electrical field it may amount to ½ per cent. of the original activity. (2) The residual activity is due to the presence of AcX. (3) The approach of the AcX to the negative electrode is not due to its high vapour pressure, neither can its presence there be accounted for by a hypothetical short-lived emanation between radio-actinium and AcX. Rather AcX goes up to the electrode in consequence of the explosive disintegration of radio-actinium. At the instant of its formation from the radio-actinium the remaining positively charged Ac atom experiences a recoil, and may be transported to the negative electrode like an ion in the electric field. If no electric field is applied, or if the opposite electrode is positively charged, no residual activity, or at the best an extremely small one, is observed. (4) In agreement with this hypothesis it is found that the residual activity cannot be obtained from pure AcX preparations, while in the case of radio-actinium this action is quite independent of the amount of AcX present. (5) Increasing the distance of the electrode from the material essentially alters the residual activity. Further researches are in progress to ascertain whether the recoil is brought about simply by the action of the emitted α-rays, or if it can be also evoked by the ejected electrons. A note is appended stating that Rutherford some time ago observed certain phenomena with the active deposit of radium which he traced to the recoil of the residual atom, and it is concluded that these phenomena are essentially similar to those described in this paper. A. E. G.

475. *Radio-active Products in Atmosphere.* **W. Wilson.** (Phil. Mag. 17. pp. 321–325, Feb., 1909.)—Describes researches on the relative amounts of radium and thorium present in the atmosphere at Manchester. A negatively charged wire was exposed, and the decay curve of the deposit obtained, readings being continued for 48 hours. The whole decay curve of the Th deposit could be deduced from the later readings, since the activity due to the Ra deposit has practically disappeared after 4 hours. The decay curve of the Ra deposit could then be obtained by subtraction. It was found, as the mean of many experiments, that 62 per cent. of the initial activity was due to the deposit from Th. Blanc obtained similar results in Rome, the activity due to the Th deposit varying from 60 to 70 per cent. of the whole. These results are discussed, and it is concluded that there must be in the earth's crust about 7×10^5 as much Th as Ra. Using Strutt's value of the amount of radium present in the surface rocks (5×10^{-12} gm. per c.cm.), this gives as the amount of thorium present about 10^{-6} gm. per c.cm. A. W.

476. *Radio-activity of some Roumanian Mineral Waters.* **Hurmuzescu** and **N. Patriciu.** (Annal. Scientifiques de l'Univ. de Jassy, 5. pp. 159–165, Dec., 1908.)—The radio-activities of the waters from eight different sources are found to range in intensity from $1{\cdot}112 \times 10^{-3}$ e.s.units at Dorna to $0{\cdot}128 \times 10^{-3}$ at the Baltzatesti (Neamtz) baths. The water at Dorna is considerably the most active, the next being a ferruginous water at Strunga, the intensity of which is $0{\cdot}810 \times 10^{-3}$. The waters possess generally a similar activity to that found for most Swiss waters. W. H. St.

REFERENCES.

477. *Improved Triple Object-glass.* **J. W. Gifford.** (Roy. Astronom. Soc., Monthly Notices, 69. pp. 118–125, Dec., 1908.)—Details of measured refractive indices of various glasses used in designing a triple objective for telescope. C. P. B.

478. *Telephotographic Objectives.* **K. Martin.** (Zeitschr. Wiss. Phot. 6. pp. 406–409, Nov., 1908.)—Busch's bis-telar lens *f*/9 was introduced in 1905. A year afterwards v. Rohr discovered an old Petzval lens of similar construction, concave components, with the concave surfaces towards one another, and with short back focus and a very flat field. The aperture was *f*/5·2; and this has led to the new Busch bis-telars *f*/7. A. D.

479. *Radio-active Changes in the Earth.* **R. J. Strutt.** (Nature, 79. pp. 206–208, Dec. 17, 1908. Discourse delivered at the Royal Institution.)

480. *Photosculpture.* **J. J. Pillet.** (Bull. Soc. d'Encouragement, 110. pp. 1281–1299, Nov., 1908.)—Method, due to M. Cardin, of reproducing in sculpture from four photographic negatives taken simultaneously in lines at right angles to one another and in the same horizontal plane. Enlargements or reductions are also possible. A. D.

481. *Errors in Measures of Star Images and Spectra.* **Perrine.** (Lick Observatory Bull., No. 143. Nature, 79. p. 320, Jan. 14, 1909. Abstract.)—Discordances found in measures of star images and spectra appear to be greater than can be accounted for by errors of measurement. It is suggested that the irregularities in size and distribution of the silver grains in the photographic film are productive of much of the trouble. C. P. B.

482. *Huyghens' Wavelets.* **C. V. Raman.** (Phil. Mag. 17. pp. 204–216, Jan., 1909.)—In a previous paper [see Abstract No. 230 (1907)] the author described an asymmetrical set of diffraction bands formed by a rectangular aperture held obliquely in a parallel beam of light. He now gives three photographs exhibiting this asymmetrical effect and develops a mathematical theory accounting for it. E. H. B.

483. *Anomalous Dispersion in the Magnetic Rotation of Polarised Light.* **G. J. Elias.** (Deutsch. Phys. Gesell., Verh. 10. 22. pp. 869–876, Nov. 30, 1908.)—A preliminary account of some experiments with a half-shadow apparatus on certain salts of the rare earths. Curves are given of the results obtained with erbium and neodymium nitrates, and these show very marked anomalies. E. C. C. B.

484. *The Fraunhofer Lines of Thallium and an Error in Rowland's New Table of Standard Wave-lengths.* **C. Fritsch.** (Phys. Zeitschr. 9. pp. 900–901, Dec. 15, 1908.)—The author points out that in Rowland's new table of wave-lengths some lines, owing to the symbol Th being used instead of Tl, are wrongly attributed to thorium. These lines are at $\lambda\lambda = 5350, 3775, 3529$, and 3519. E. C. C. B.

485. *Grating Spectrum of Radium Emanation.* **T. Royds.** (Phil. Mag. 17. pp. 202–204, Jan., 1909.)—A measurement of the spectrum of radium emanation with a grating of 1 m. focus. The values are given in the paper and have a probable error of 0·1 Å.U. E. C. C. B.

486. *The Zeeman-effect and the Second Law of Thermodynamics.* **M. Tenani.** (Accad. Lincei, Atti, 17. pp. 714–717, Dec. 20, 1908.)—The author points out that according to the magneto-optic theory of W. Voigt the intensity of the components of the doublet emitted longitudinally to the magnetic field should not be the same as the components emitted transversely to the field, and hence the second law of thermodynamics is not necessarily contradicted. [See Abstracts Nos. 1095, 1623, and 1950 (1908).] S. G. S.

487. *Optical and Magneto-optical Phenomena of Crystals at Low Temperatures.* **J. Becquerel.** (Comptes Rendus, 148. pp. 158–161, Jan. 18, 1909.)—The author critically discusses a recent paper by du Bois and Elias [see Abstract No. 1108 (1908)] and shows that their results are not actually in disagreement with his own views and experiments. E. C. C. B.

488. *Electrochemistry of Light.* IV. **W. D. Bancroft.** (Journ. Phys. Chem. 13. pp. 1–90, Jan., 1909.)—In this paper, the first of two dealing with the problem of solarisation, the author summarises a portion of the literature of the subject. T. H. P.

489. *Radio-activity of some Austrian Springs.* **M. Bamberger.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 1055–1064, July, 1908. From the Laborat. f. anorg. Chemie d. k.k. techn. Hochschule, Wien.)—Tabulated values of the activity observed. L. H. W.

HEAT.

490. *New Model of N. A. Hesehus' Calorimeter and Determination of Specific Heats of Alloys of Tin and Bismuth.* **N. A. Marenin.** (Jurn. Russk. Fisik.-Chimičesk. Obščestva, 40. No. 9. pp. 893–898 [Physical Part] 1908.)—This model of Hesehus' calorimeter (Journ. de Phys. p. 489, 1888) allows of the weight of water in the calorimeter tube being determined by weighing this tube alone instead of the whole calorimeter. The author has measured, for alloys of bismuth and tin containing from 0 to 100 per cent. Bi, (1) the temperatures of fusion; (2) the specific heats, which increase continuously with the content of Bi; and (3) the densities, which diminish continuously as the percentage of Bi increases. T. H. P.

491. *Effect of Tension on Thermal and Electrical Conductivity.* **N. F. Smith.** (Phys. Rev. 28. pp. 107–121, Feb., 1909.)—The object of the present investigation is to determine what changes, if any, are produced in the thermal conductivity of metal bars when they are subjected to a stretching force, and to compare these changes with those which are produced in their electrical conductivity. In neither case is any attempt made to determine the absolute value of the conductivity, but merely the percentage change produced by the stretching force. Full details of the methods adopted and apparatus used are given. The method used for the thermal problem is substantially that of Wiedemann and Franz, while in studying the changes in the electrical conductivity a modification of the Kelvin double-bridge method is used. Bars of Fe, steel, Cu, brass, Al, and Zn are experimented with, and the following results obtained: An apparent change in the thermal conductivity of the same bar, under the same tension, takes place from day to day, which may be due in part to changes in the character of the surface of the bar. In every case the thermal conductivity of the bar increases when a moderate tension is applied: as the limit of elasticity is reached this increase approaches a maximum; as the tension exceeds this limit, the conductivity remains practically constant in the case of the more elastic metals, or begins to diminish, in the case of the softer metals. After a bar has been stretched its conductivity does not return at once to its former value; this is most noticeable in steel and brass. In the case of the softer metals the return to the original value is more perfect. The total change in the conductivity of steel may amount to 7 or 8 per cent., that of iron 4 or 5 per cent., of brass about 4 per cent., copper 2 or 3 per cent., and Al about ½ per cent. The measurements made with the zinc bars are unsatisfactory. In every case the electrical resistance increases (conductivity diminishes) with increasing tension. It is of interest to note that the changes in the thermal conductivity produced by moderate tensions are opposite in direction to those in the electrical, and are of an order of magnitude about 10 times greater. A. E. G.

492. *Boiling-point of Radium Emanation.* **E. Rutherford.** (Nature, 79. pp. 457–458, Feb. 18, 1909.)—To test the boiling-point of pure emanation at atmospheric pressure, purified emanation corresponding to an equilibrium amount from about + 100 mgm. of radium is compressed into a glass capillary of about 1/20 mm. diam. The end of this capillary tube dips into a pentane bath which can be cooled to any desired temperature, the latter being measured by a thermo-couple. The point of initial condensation is marked by the appearance of a brilliant point of phosphorescent light. In this way it is found that the temperature of the initial condensation of the emanation rises from —150° C. at very low pressure to about —65° C. at atmospheric pressure. Comparing the boiling-point (208° abs.) of this inert gas with those of argon (86·9° abs.), krypton (121·8° abs.), and xenon (163·9° abs.) it will be noted that the boiling-point of krypton is about intermediate between that of argon and xenon, while that of xenon is nearly the mean between that of krypton and the emanation. A. E. G.

493. *Theory of the Greenhouse.* **R. W. Wood.** (Phil. Mag. 17. pp. 319–320, Feb., 1909.)—The comparatively high temperature produced within a closed space covered with glass and exposed to solar radiation is usually held to result from a transformation of wave-length; that is, that the heat waves from the sun, which are able to penetrate the glass, fall upon the walls of the enclosure and raise its temperature: the heat energy is re-emitted by the walls in the form of much longer waves, which are unable to penetrate the glass, the greenhouse acting as a radiation trap. The author thinks it more probable that the part played by the glass is the prevention of the escape of the warm air heated by the ground within the enclosure, and describes experiments to confirm his ideas. It was found that the loss of temperature of the ground by radiation is very small in comparison to the loss by convection, so that little is gained from the trapped radiation. From this it seems doubtful if the atmosphere is warmed to any great extent by absorbing the radiation from the ground; hence it does not appear necessary to pay much attention to trapped radiation in deducing the temperature of a planet as affected by its atmosphere. A. W.

494. *Radiation and Temperature of the Bunsen Flame.* **E. Bauer.** (Comptes Rendus, 147. pp. 1397–1400, Dec. 21, 1908.)—The author describes experiments on absorption and emission in which light from a Nernst lamp is passed through a flame, the rays which pass through then traversing a hole in a double-walled screen maintained at constant temperature by a current of cold water; subsequently the rays are reflected from three fluorspar surfaces and concentrated by a concave mirror on to a sensitive micro-radiometer. It is found that coal-gas flames have considerable emissive and absorptive power for the residual rays from fluorspar [see Rubens, Abstract No. 47 (1900)], a flame 5 cm. long absorbing 18 per cent. of the rays emitted by a Nernst lamp. This absorption and the corresponding emission are due to water-vapour, and on introducing the latter into the gaseous mixture of a Meker burner the emissive power of the flame can be increased to the extent of 50 per cent. [see Rubens and Aschkinass, Abstract No. 21 (1899)]. The absorption by the flame of the residual rays is selective. The temperature of the flame is found to be 1,760 ± 50° at a certain distance above the blue inner cone. T. H. P.

495. *Molecular Motion and Dispersion in Gases.* **J. Laub.** (Ann. d. Physik, 28. 1. pp. 131–141, Dec. 28, 1908.)—A highly mathematical discussion of dispersion phenomena in gases on the electron theory in which it is shown that the effect of molecular motion (1) is proportional to the absolute temperature, (2) increases with the density of the gas, and (3) is greater the nearer is the frequency of the exciting waves to that of the natural vibrations of the molecule. E. H. B.

496. *Law of Probability for a System of Correlated Variables.* **S. H. Burbury.** (Phil. Mag. 17. pp. 1–28, Jan., 1909.)—The author defines correlation as follows: Let x and y be two quantities each of which varies continuously between its own limits, and let them be independent variables, in the general sense, that if either be given, the other is not thereby determined, but may vary continuously through a finite range of values. That is, the system of x and y has two degrees of freedom. Many difficult problems in the theory of probability are then solved, and several interesting practical applications of the results to the kinetic theory of gases are made. It is proved, for example, that consistently with the theory of probability inequalities of density may arise at any time. But so long as the system remains gas, they will be dispersed by diffusion as fast as they arise. The uniformity of density is therefore stable. In the critical case, however, the portion of gas which assumes the greater density becomes liquid and is not dispersed by diffusion. Liquefaction will therefore take place of certain portions of the gas successively, other portions remaining as gas unaffected until, with continuing compression, they undergo liquefaction in their turn. A. R.

497. *Brownian Motions.* **Chaudesaigues.** (Comptes Rendus, 147. pp. 1044–1046, Nov. 30, 1908.)—Quantitative tests of Einstein's formula were made with an emulsion of gamboge containing measurable grains of the same size. Forty grains 0·45 μ in diam. were followed in their motions every 30 seconds, and three series of 50 grains, each 0·218 μ in diam., were similarly followed in pure water, and in water rendered 1·2 or 4·6 times more viscous by the addition of sugar. Einstein's formula—

$$\overline{\Delta x^2} = (t\mathrm{RT/N})(1/8\pi a\mu),$$

was found to be accurately true as regards the effect of the diam., the viscosity, and the time. The value of the formula in the absolute sense may be tested by determining N from it. The result is 64×10^{22}, which compares well with Perrin's value $70{\cdot}5 \times 10^{22}$. Einstein's formula may therefore be taken as exact. [See, however, Abstracts Nos. 1456, 1457, 1816 (1908).] E. E. F.

REFERENCES.

498. *Thermodynamics of Moving Systems.* **F. Hasenöhrl.** (Akad. Wiss. Wien, Sitz. Ber. 116. 2a. pp. 1391–1405, Nov. and Dec., 1907, and 117. 2a. pp. 207–215, Feb., 1908.)—These two highly mathematical papers practically form a reply to Planck's communication [see Abstract No. 1480 (1907)].

499. *Heat Conductance of Composite Bodies.* **C. Hering.** (Electrochem. Ind., N.Y. 7. pp. 11–14, Jan., 1909.)—Suitable forms are indicated for the formulæ for calculating heat resistance and conductance of walls consisting of several layers, or having pieces inset so that bodies of different thermal conductivity are in parallel. Examples given are furnace walls of firebrick, infusorial earth, and felt, and also electrodes passing through a firebrick wall. F. R.

500. *Molecular Dimensions in Kinetic Gas Theory.* **M. Reinganum.** (Ann. d. Physik, 28. 1. pp. 142–152, Dec. 28, 1908.)—A discussion of molecular dimensions in the light of the recent paper by Sirk [Abstract No. 1120 (1908)] dealing especially with the laws of attraction and the nature of the contact, or the repulsion which replaces contact, in an encounter of molecules. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

501. *Molecular Attraction for Electrical Double-points.* **J. D. van der Waals, Jr.** (Konink. Akad. Wetensch. Amsterdam, Proc. 11. pp. 315–316, Nov. 26, 1908.)—In the approach of electrical double-points or bi-poles by their mutual attraction, the author points out in the present note that their rotations as well as translations must be considered. He still believes that the way the attraction depends upon distance is that previously indicated by him [Abstract No. 1660 (1908)], but that the coefficients have different values from those assigned if the rotation be left out of account. E. H. B.

502. *The Principle of Relativity.* **A. H. Bucherer.** (Phil. Mag. 16. pp. 939–940, Dec., 1908.)—A protest against the view still held by E. Cunningham that Bucherer's principle of relativity leads to the same forces as the Lorentz-Einstein principle. The present author recognised from the first that the question as to which of the various theories represented the law of nature was one for experiment to decide. He has now completed the experiments foreshadowed in April, 1907 [see Abstract No. 1048 (1907)], and in contradiction to Kaufmann has verified the substantial accuracy of the Lorentz formula for the electromagnetic mass, and therefore also of the Lorentz-Einstein principle of relativity, since the only serious objection to its complete acceptance has been removed. E. H. B.

503. *Electron Theory of Metals.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 848–867, June, 1908.)—This is a mathematical paper in which results are obtained for various electrical phenomena, similar to those of H. A. Lorentz, by methods which are claimed to be much more simple. In the investigation it is assumed that all metals are built up of atoms, positive and negative electrons. The positive electrons move very slowly in comparison with the negative, so that in most cases we may look upon them as bound to the atom, and their number is regarded as equivalent to that of the atoms. In electrically neutral metals the number of positive and negative electrons are regarded as equal since each is assumed to carry an atomic charge. Some of the negative electrons are bound, some free; the free move among the atoms like gas molecules in a porous body, but with greater velocities; hence the kinetic theory of gases can be applied in considering these free negative electrons. They possess a kinetic energy proportional to the absolute temperature, and to them is due a share of the atomic heat of the metal. Arguments and tables are given to show that if the number of free-moving negative electrons is equal to the number of atoms, this share amounts to about one-half the total atomic heat. Some of the atomic heat must be due to the atoms themselves, hence the number of free electrons cannot be greatly in excess of the number of atoms, and likewise equal atomic quantities of different metals must possess similar numbers of free electrons. Neutral, negatively, and positively charged bodies, and the behaviour of a metal in an absolute vacuum are then considered. Expressions are obtained for contact p.d. and the Peltier-effect. Like results are found for these, and an expression is found for the Thomson-effect, by assuming that the electrons behave in a metal like a gas, and then applying the fundamental hydrostatic equations. In this more simple manner, by assuming that only the negative electrons are able to move, it is possible to consider most of the electrical phenomena; but so soon as it is assumed that the positive electrons also move, all those difficulties appear which have been referred to by Lorentz. **A. E. G.**

504. *Glow Generated by Electrostatic Induction in an exhausted Receiver, and Action of a Magnetic Field on the Glow.* III. **F. J. Jervis-Smith.** (Roy. Soc., Proc. Ser. A. 81. pp. 480–488, Dec. 22, 1908.)—A continuation of the author's experiments upon the production of luminescence in gases under reduced pressure when moving in an electrostatic field. [See Abstract No. 1822 (1908).] A silica bulb containing O_2 was rotated 4 to 5 times a second between the poles of an inductor which was gradually charged until the gas glowed, then slowly discharged until the glow died out. The glow was at once restored on establishing a magnetic field. When the residual gas was air the magnetic effect was less and again glass bulbs did not give such marked results as did the silica one. When the residual gas was Ne no afterglow was observed when the bulb was placed between the poles of an induction coil. The magnetic field had very little influence on a bulb of Ne compared with that described above for O_2. When a silica bulb with air was rotated at such a distance from the inductor (charged to 800 volts) that it showed no glow, the establishment of a magnetic field at once produced a glow. A silica bulb with air was rotated, between the poles of a large electromagnet, in contact with a camel-hair brush, the pressure of the brush being so adjusted that no glow was visible. The establishment of the magnetic field at once caused the glow to appear and it ceased immediately the field was removed. If the brush was removed before the magnetic field was established the glow still appeared, sometimes lasting 8 minutes before it died out.
E. C. C. B.

505. *The Variation in the Number of Ions in the Free Atmosphere.* **D. Isitani.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. No. 21. pp. 416–420, Nov., 1908.)—The author gives the mean hourly values of the number of ions present in the atmosphere as determined from experiments made at the Central Meteorological Observatory at Tōkyō in fine, calm weather during May and June, 1908:—

Hours	7–8	8–9	9–10	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18
n_+ ...	229	495	462	685	471	436	615	667	688	457	442
n_- ...	246	249	278	816	882	875	294	885	844	406	828

Similar experiments at Kusatsu made during March and April gave the following values:—

Hours	8–9	9–10	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18
n_+ ...	1,530	1,450	1,200	1,120	899	1,250	1,170	1,820	1,820	1,830
n_- ...	888	848	882	725	578	891	1,050	909	1,080	965

Observations taken during a heavy snowstorm (depth of snow 1 m.) showed a considerable decrease in the number of ions of each sign, but the positive remained in excess. [See also Abstract No. 114 (1909).] **R. G. K. L.**

506. *Dispersion of Electricity during Evaporation of Liquids.* **A. Gallarotti.** (Accad. Lincei, Atti, 17. pp. 709–714, Dec. 20, 1908.)—The author has compared, by means of a gold-leaf electroscope, the rate of loss of charge from an insulated vessel when empty, and when water or sulphuric ether is evaporated therefrom, in a current of dry air freed from ions by passage through cotton-wool. With the method adopted it was possible to measure a fall of potential of 2·2 volts, which corresponds, with the vessel employed and the time of experiment, to a loss of charge of $2\cdot10^{-7}$ e.s. units, but no appreciable difference in the rate of discharge during evaporation of the liquids could be detected, and hence Exner's theory of the distribution of potential in the atmosphere is regarded as untenable. [See Abstracts Nos. 879 (1901) and 1846 (1902).] W. H. Si.

DISCHARGE AND OSCILLATIONS.

507. *Mobility of Ions.* **K. Przibram.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 665–689, May, 1908. Physik. Inst. d. Univ., Wien.)—Determination of the mobility of ions in a series of vapours. The size of the ions, as deduced from their mobilities, corresponds approximately, for water, methyl alcohol, and ethyl alcohol, to the values as determined from condensation experiments, assuming that the vapours are first condensed upon their own ions. A. D.

508. *Mobility of Ions in Gases.* **A. Blanc.** (Journ. de Physique, 7. pp. 825–889, Nov., 1908.)—Methods based upon Rutherford's alternating-field method. The mobility (= velocity attained per unit potential-gradient) is for positive and negative ions respectively: air, 880 and 600; CO_2, 250 and 808; H, 1,600 and 8,000. Moisture diminishes the mobility of negative and increases that of positive ions. The hydrogen data tend towards want of precision; but not when a little CO_2 is added. Data are given for various mixtures. The mass of the ion, positive or negative, must be considerable in relation to the mass of a molecule of the gas. A. D.

509. *Electrified Centres of Low Mobility in Gases.* **de Broglie.** (Annal. Chim. Phys. 16. pp. 5–69, Jan., 1909.)—A mixture of air and hydrogen, passed through a red-hot tube contains material centres, charged both positively and negatively, and having the mobility of large ions: this property is related to the possible formation of condensible products, say H_2O, and no such result follows when the products are all gaseous in the cold (*e.g.*, in a mixture of air and CO); and the conductivity of the gases from a CO-flame depends solely on the presence of small ions (corpuscles). In a gas there can exist in suspension certain neutral centres capable of being converted into large ions by various agents such as produce small ions, such as radium, Röntgen rays, ultra-violet rays, CO-flame gases: these centres exist specially in flame-gases, and in gases splashed up with certain liquids such as benzol, and may be formed by heating bodies slightly damped, and they can become charged if splashed up with ionising liquids (water, saline solutions, alcohols). Liquids divide into two groups, those which yield to gases shaken up with them ions electrically charged and those which yield neuter ions. Radium acts on gases emerging from ionising liquids in the sense of diminishing the number of charged centres. The dust suspended in a conducting gas in an electrostatic field comprises ions of both signs and neutral centres; these have been observed and their mobility measured by ultramicroscopic optical methods, which confirm the results of electrometric methods. A. D.

510. *Gaseous Ionisation and Pressure.* **T. H. Laby and G. W. C. Kaye.** (Phil. Mag. 16. pp. 879–889, Dec., 1908.)—Ionisation-pressure curves were determined over a range of pressures from 1 to 17 atmos. for hydrogen, air, and CO_2, when contained in an Al vessel and exposed to hard γ-rays from radium. In hydrogen the ionisation is approximately proportional to the pressure: in air it increases less rapidly than the pressure, in CO_2 still less rapidly than the pressure, especially at the higher pressures. It is concluded that the ionisation arising from γ-rays, which is small in amount, varies as the pressure; that the secondary β-rays (excited by the γ-rays) from the Al electrodes vary as the pressure, while those excited in the gas itself produce ionisation small in amount and proportional to the square of the pressure, and finally that the ionisation from a soft tertiary radiation increases less rapidly than the pressure. T. M. L.

511. *Ionisation Remanent in Gases.* **J. P. V. Madsen.** (Roy. Soc. of South Australia, Proc. Vol. 32. pp. 12–34, 1908.)—Experiments upon ionised gases blown through gauzes are in agreement with the theory of Bragg and Kleeman [Abstract No. 929 (1906)], that there exists an initial recombination between a molecule ionised by α-rays and the ejected electron or electrons. There is no trace of such effect when the gas is examined $\frac{1}{10}$ to $\frac{1}{50}$ sec. after the act of ionisation. The action of gauzes, electrified or unelectrified, upon ionised gases blown through them is to be explained by the aid of the theory of diffusion. Gauzes can be so arranged as to remove from an electric field all the ions of one sign from a very defined region in a tube along which the ions are carried by a current of gas. The ionisation produced in air by Röntgen rays or by a wire made active by exposure to thorium emanations is the same in air which has just previously passed under the influence of uranium radiation as in air not so treated. A. D.

512. *Effect of Pressure on Ionisation.* **W. Wilson.** (Phil. Mag. 17. pp. 216–225, Jan., 1909.)—Experiments were made on the natural ionisation of air in a thick-walled iron vessel in which the pressure was raised to various values up to 45 atmos. The curve obtained showing the relation between ionisation and pressure is a straight line which curves over somewhat towards the pressure-axis at pressures of about 8 atmos. or less. The curve due to ionisation excited inside the vessel by external γ-ray radiations was previously determined. This is a dissimilar curve, and the natural ionisation in the vessel is not wholly due to external γ-rays, though it is partly due to this cause. The number of ions produced per c.cm. per sec. is calculated to be 18·1. The experimental curve can be made up of two parts: (1) A constant part due to radiations from the sides of the vessel; (2) a part which increases proportionally to the pressure, due chiefly to an emanation mixed with the gas, but partly also to penetrating radiation, the latter part being very small. The emanation is probably that of radium. The curvature of the lower portion of the curve is probably due to radiations shot out obliquely from the sides of the vessel which strike another side before completing their full path. The ionisation due to the emanation present is calculated to be only 0·80 ion per c.cm. per sec. As the capacity of the vessel was 1,000 c.cm. this corresponds to 1 α-particle in every 125 sec.; and 1 atom in every 463,000 disintegrates per sec. in the case of Ra Em; thus the number of emanation atoms present must be 8,700, or 8·7 per c.cm. This is a very small amount, and cannot be expected to be got rid of. The effect of this small quantity is practically unmeasurable at atmospheric pressure. J. J. S.

513. *Charges on Ions in Gases, and Effect of Water-vapour on the Motion of Negative Ions.* **J. S. Townsend.** (Roy. Soc., Proc. Ser. A. 81. pp. 464–471, Dec. 31, 1908.)—It is first shown that positive ions with single or double atomic charges can be produced by secondary Röntgen rays. Then by absorbing the non-penetrating secondary rays by a thin layer of vaseline, it is found that it is the more penetrating secondary rays which produce positive ions with double charges. In all cases the negative ions have a single atomic charge. In order to explain the effect of moisture on the motion of the negative ions the theory of the experiments is next investigated. In the apparatus used some of the ions generated by the secondary rays pass through a grating under the electric force, and then through an aperture vertically below it, and so into a uniform electric field Z. The stream of ions now opens out, the central portion falls on a disc, and the remainder on a ring surrounding it; both the disc and ring are cut from the same sheet of brass. The charges n_1 and n_2 received by the disc and ring respectively are accurately measured by a special form of induction balance. It is now proved that the ratio R of the charge n_1 received by the disc to the total charge $n_1 + n_2$ is a function of (N, e, Z), where N is the number of molecules per c.cm. in a gas at atmospheric pressure and at a temperature equal to that of the gas in the experiments, e is the atomic charge in e.s. units, and Z the electric force in volts per cm. [see Abstract No. 662 (1908)]. The gas is dried for several weeks, and then curves representing R as a function of Z are obtained for pressures of 16·5 mm., 11 mm., and 5·5 mm. of the gas. A curve showing the theoretical relation between these quantities is also given. These indicate that the stream of ions opens out considerably when the pressure is lowered, also that for larger values of Z the spreading out of the ions does not alter much. These results have been obtained for negative ions both with and also without vaseline, but for positive ions when the gas is dry R is found to be independent of the pressure, and it also varies with Z when some definite value is given to Ne. When water-vapour of partial pressure less than $\frac{1}{10}$ mm. is admitted, the ratios R for the negative ions return at once to their theoretical values, and are independent of the pressure. No noticeable change is observed in the total number of ions produced when the water-vapour is admitted. Mathematical and experimental evidence is next given to prove that the effects observed with negative ions in a dry gas may be attributed to the increase of partial pressure which they can acquire when they are of small dimensions. When water-vapour is present the motion of the negative ions corresponds to that of the positive ions; this may be taken to indicate that water-vapour tends to condense on the negative ions even at very low pressures. Water-vapour, however, does not condense on these ions when they move at high velocities under large forces and small pressures. It may be that the motion of the negative ions in gases at high pressures is not influenced by small traces of water-vapour. Experiments to test this are being made. A. E. G.

514. *Charges gained by Conductors.* **J. K. Robertson.** (Phys. Rev. 27. pp. 400–424, Nov., 1908.)—McLennan and Burton found in 1903 that a metal cylinder placed within and insulated from an outer earthed one of the same material gradually acquired a negative charge which rose to a maximum depending on the metal. McKeon found lead and tin to acquire positive charges, and the charges underwent variations which suggested a connection with the diurnal variations in the ionisation of atmospheric air. The author found the charge to depend on the treatment (*e.g.*, cleaning) of the surface;

variations did not show any marked periodicity; the presence of radium bromide accelerated but did not increase the values obtained; and apparently the results are affected by the growth of deposits removable by cleaning. This tells against the charges being due to ionisation of the enclosed air. Experiments on the Volta-effect showed results affected by the conductivity of air and by secondary radiations. In the gradual charging of the metal conductor both the Volta-effect and secondary radiations play a part, but further research is required A. D.

515. *Röntgen Rays and Glow Discharge.* **E. Marx.** (Phys. Zeitschr. 9. pp. 781–782; Discussion, pp. 782–786, Nov. 1, 1908. Paper read before the 80. Naturforscherversamml., Köln. Ann. d. Physik, 28. 1. pp. 153–174, Dec. 28, 1908.)—When a platinum electrode in a positive condition is struck by Röntgen rays, a glow discharge, if not already started, is inhibited; while if the Pt electrode be negative, under the same conditions the discharge is facilitated. A. D.

516. *Radiations and Explosive Potential.* **G. Moreau.** (Journ. de Physique, 8. pp. 16–33, Jan., and pp. 94–110, Feb., 1909.)—The lowering of the explosive potential of an oscillating spark may be measured with precision by the variation of the effective current-strength of the discharge. Radiations from radium, and ultra-violet light, do not modify the oscillatory character of the discharge. They notably lower the explosive potential. The lowering increases with the intensity of radiation down to a limiting value independent of the active source, but variable with the nature of the metal of the electrodes and of the dielectric gas. Flame gases also lower the explosive potential without going below the same limit. The lowering increases as the pressure of the gas surrounding the electrodes diminishes down to a max. lowering equal to the limiting lowering above mentioned. Radium acts by the most rapid of its β-rays. The orientation of the vibrations of ultraviolet light makes no difference. The principal results of the inquiry can be explained as due to ionisation by impact of the molecules in the spark-gap. A. D.

517. *Luminescence from Canal Rays.* **V. Carlheim-Gyllensköld.** (Ark. för Mat. Astron. och Fysik, Stockholm, Vol. 4. No. 33. pp. 1–44, 1908.)—Comparisons of the luminescences caused by canal rays and by kathode rays in the compounds of alkali or alkaline-earth metals. The luminous intensities of different parts of the spectrum are examined and the results reduced to terms of heat-energy. The salts, judging from the faint spectra produced, are brought locally to extremely high temperatures by canal rays. Canal rays make line spectra where kathode rays make continuous or band spectra. The facts are well connected by assuming that the radiation produces in the compound a chemical reaction in which the kathions or anions change places with the positive or the negative particles of the exciting rays. The temperatures, as determined from the distribution of energy in the spectra, are of the same order as those deduced by theory from the kinetic energy of the exciting particles by an entirely different method. A. D.

518. *Generation of Fluorescence through Kathode Rays.* **O. Reichenheim.** (Deutsch. Phys. Gesell., Verh. 11. 2, pp. 45–49, Jan. 30, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—Lilienfield has observed, under suitable conditions, that during the discharge through gases contained in

glass or quartz vessels, the glass or quartz fluoresces in colours ranging from ruby-red to deep blue. It has not been observed previously that this fluorescence can be set up by the direct action of kathode rays, so it has been assumed that the glass fluoresces in this manner only under a very intense slow-moving radiation, while the ordinary green fluorescence is brought about by the quick rays. The direct influence of the kathode rays is shown by using a modified form of the apparatus employed by E. Goldstein for showing the secondary kathode rays given out by insulated bodies. The kathode is an Al plate about 8 mm. diam. firmly placed in a glass tube, which tube projects 1 cm. in front of the plate. With suitable pressures a very intense needle-like kathode radiation comes out from the end of the glass tube. In the path of this and about 2 cm. from the tube end a quartz plate is placed. The discharge tube had for some time previously dry oxygen passed through it. Where the rays struck the quartz plate a fluorescence at first red, then violet, and ultimately sky-blue occurred. If oxygen is left in the tube some minutes, and then the tube exhausted, the fluorescence is at first red, but gradually changes to blue. The red colour seems to be due to occluded oxygen, for when, owing to the heating of the plate by the rays, this is set free, the blue colour appears. Two explanations are offered as to the probable cause of the blue fluorescence. Either it is brought about by the absorption of the primary rays, and is quite independent of the secondary radiation set up at the same time, or there is a direct connection between it and the emission of secondary rays. To test this, heated glass is used as a kathode, and the entire emission of the kathode rays is limited to a few mm.^{2}. The solid glass knob which is used for kathode is heated by a current passed through a Pt wire which has been doubled and fused into it. This kathode is enclosed in a glass tube the end of which projects 2 cm. beyond the end of the glass knob. With a suitable current the surface of the knob begins to give a blue fluorescence, and at this place the glass devitrifies and becomes dull. If the action is continued the blue colour becomes more pronounced. The phenomena which occur at the kathode are of so complicated a nature that the blue colour cannot be affirmed to be due to the emission of kathode rays, it may be due to the so-called K_1 rays, or even to the canal rays which strike it. The emission of electrons suggests itself as the most probable cause. Crystallised quartz, porcelain, and calcium oxide, as well as amorphous quartz and glass, give this blue fluorescence, but it is difficult to prove by spectroscopic means that the blue is the same in each case. A. E. G.

519. *Variations in Conductivity of Air enclosed in Metallic Receivers.* **C. S. Wright.** (Phil. Mag. 17. pp. 295–318, Feb., 1909. Paper read before the Roy. Soc. of Canada, May 28, 1908.)—Previous measurements of the same nature are referred to, and a table of the results obtained is given. The object of the present experiments is to observe the conductivity of the air confined in metallic vessels possessing little if any radio-active impurity, and to determine the portion due to an intrinsic activity of the metal. Lead, zinc, and Al cylinders are used for this purpose. An arrangement is employed by which a sliding tube condenser can be used to annul any charge the gold-leaf system acquires through the conductivity of the air in the receiver, the motion of the tube being so regulated as to keep the potential of the gold-leaf always at zero. Hence in order to determine "q" (the number of ions generated per c.cm. per sec.) it is only necessary to know the charge annulled in the time during which the compensating tube is moved a standard distance, and the volume of the receiver. Details are given of experiments in which

the Wilson electroscope is used, as well as of others in which the electroscope is replaced by a Dolezalek electrometer. The following are the principal conclusions arrived at from the experimental results. (1) No evidence of a regular daily variation is found. (2) A penetrating secondary radiation is set up in the brick wall of a room by penetrating rays such as those from radium. (3) The water of Lake Ontario, which contains no appreciable radio-active emanation, acts as a perfect screen, both for the earth's radiation and, if a sufficient depth be taken, for the γ-rays from radium. It is therefore possible by experiments made over that lake to determine what portion of the ionisation in the receivers used is due to residual active impurities, and what part to the intrinsic activity in the metals of the receivers. (4) The ionisation in free air due to radio-active impurities in a clay soil is found to be 0·9 ions per c.cm. per sec.—a value in close agreement with that of Strong (0·8), which he deduced from Strutt's determination of the earth's radium content. (5) The ratio of the ionisation in cylinders of Pb, Zn, and Al due to radiations from the earth is found to be 1·1 : 1·23 : 1·0, whilst that due to γ-rays from radium is 1·4 : 1·14 : 1·0. This result, however, needs confirmation. (6) The values obtained in the open for the ionisation in well-cleaned receivers of Pb, Zn, and Al are lower than any hitherto recorded, the numbers 8·6, 6·0, and 6·5 respectively being obtained as the value of q when the experiments were carried out over Lake Ontario. Considering the difference in the atomic weights of the metals used, and that radio-activity is a property associated with the atomic structure, it would seem that in receivers made from absolutely pure metals, the ionisation might drop to a very low value, or even vanish, if the experiments were conducted under suitable conditions. A. E. G.

520. *Occlusion of Residual Gas, and Fluorescence of the Glass Walls of Crookes' Tubes.* **A. A. Campbell Swinton.** (Roy. Soc., Proc. Ser. A. 81. pp. 453–459, Dec. 31, 1908.)—The author has previously described experiments indicating that the occlusion of gas is due in some instances to the gas being mechanically driven into the glass, in which it forms bubbles on the glass being strongly heated [Abstract No. 660 (1908)]. That explanation has since been questioned, thus: (1) J. J. Thomson has suggested that the kathode-ray bombardment raises the temperature of the glass sufficiently to allow hydrogen and helium to diffuse into it; (2) R. Pohl maintains that the formation of bubbles is entirely due to films of Al disintegrated from the electrodes, and to chemical action connected with the oxidation of this Al when the glass is heated; while (3) Soddy and Mackenzie came to the conclusion that the gas generated by chemical decomposition of the glass under the influence of local heating is the cause of the bubbles [see Abstract No. 657 (1908)]. When a vacuum tube is used in which the electrodes are two caps of tin-foil on the outside of the tube, the glass when broken up and strongly heated is immediately filled with small bubbles, which, however, penetrate only to a depth of 0·025 mm. as against a depth of 0·122 mm. when internal electrodes are used. This disposes of Pohl's theory that a film of metal is necessary on the inside of the tube for the production of the bubbles. By grinding away the inner surface of the glass it is possible to prevent the formation of bubbles when the glass is subsequently heated. The amount which it is necessary to remove ranges from 0·0025 mm. with external electrodes, to 0·015 mm. with internal electrodes. This is then compared with the max. thickness (0·014 mm.) of Al which kathode rays can pass through in any quantity, and the results are seen to agree very closely, since the density of Al is 2·7, and that of glass 2·47. It does not seem possible that the temperature of the glass can be raised sufficiently when using external electrodes to permit either of J. J. Thomson's explanation or that of Soddy and Mackenzie. The fatigue of the glass in respect to fluorescence is next shown to be due in some cases to deposits of Al, or other electrode matter, or carbon on the glass. It is also found to occur where there are no such deposits. In this case when the glass is removed from the inner surface by grinding, it is possible to cause it again to fluoresce. The thickness of glass which it is necessary to remove for this purpose is 0·017 mm.; from which it appears that the fatigue of the glass is also intimately connected, in some cases, with the penetration of the gas. The fact that a small portion only of the fatigue effect is permanent may be due to the gradual escape of gas which has been driven into the glass too small a distance for the latter to be able to retain it permanently.

A. E. G.

521. *Vacuum Tubes.* **A. Henry.** (Journ. de Physique, 8. pp. 33–38, Jan., 1909.)—Vacua of 0·2 mm. can be produced in tubes filled with water-vapour from slaked lime which is then allowed to re-absorb the water-vapour. Though this vacuum is low the tube shows Crookes' effects; and it does not lose the phosphorescent effect and begin to act as a Geissler tube until the pressure is raised as high as 5 mm. by liberating water-vapour through warming the slaked lime. A focus tube made in this way acts well up to pressures of 2·0 mm., but the Al window acquires a white non-conducting coating, due apparently to ozone in the tube.

A. D.

522. *Potential Gradient in Glow Discharges.* **J. W. Bispham.** (Roy. Soc., Proc. Ser. A. 81. pp. 477–495, Dec. 31, 1908.)—The distribution of electric force along the axis of glow discharges from a charged point to a neighbouring plane was investigated. The experiments lead to the conclusion that all the types of striated glow-discharge, in which the glow spreads out from the point to the plate in a more or less conical form, are of an intermittent character. It was found that in the case of hydrogen, when the pressure was about 1 cm. of mercury, two types of continuous discharge were possible, one for small currents and the other for larger currents. In the first there was only luminosity in the neighbourhood of the point. But for larger currents, this point glow form changed over unstably to another form, in which a much lower e.m.f. maintained the larger current, and the form of discharge was then that obtained between small plane electrodes. With a large external resistance in circuit an intermediate unstable condition could be examined in which the discharge was intermittent. The distribution of electric force along the axis was obtained by first observing the distribution of potential along the axis and hence deducing the electric force graphically. The exploring electrode was formed of a fine Pt wire 1/1000 in. in diam., covered by a very fine capillary tube of glass to within 1/5 mm. of its tip.

J. J. S.

523. *Cantor's Electric Effect.* **E. Meyer.** (Phys. Zeitschr. 10. pp. 90–91, Feb. 1, 1909. Physikal. Inst. d. Univ., Zürich.)—M. Cantor recently observed the quick discharge of a charged electroscope near a sharp corner in a metallic film carrying a current, and attributed this effect to the inertia of the electrons which shot out of the conducting film at the corner [see Abstract No. 272 (1909)]. The present author regards this as unlikely since the speed of the electrons due to the e.m.f. in a circuit is usually small. Further, on repeating the experiment he finds that a telephone yields a sound as though there were a bad contact at the corner, also the corner usually glows in the dark. If there is no sound at the telephone no discharge of the electroscope occurs. Again, if a fine cut is made in a straight metallic film carrying a current, an electroscope near the cut is discharged. The discharges in these cases and in Cantor's experiment are here attributed to ionisation of the air near a bad contact or a sharp corner. E. H. B.

524. *Ruhmkorff Coil with Electrolytic Interrupter.* **L. Amaduzzi.** (Accad. Lincei, Atti, 17. pp. 705–709, Dec. 20, 1908.)—In a previous paper the author has described the peculiar behaviour of a Ruhmkorff coil with Wehnelt interrupter, as the resistance or inductance of the primary circuit is varied [see Abstract No. 580 (1905)]. Instead of using the discharge in air, the emission of Rontgen rays by a tube actuated by the coil is employed and it is found that as the resistance or inductance of the primary circuit is decreased, a minimum of activity is reached, beyond which a diminution of resistance or inductance causes an increase in the activity. The author then gives an explanation of the effect. Diminishing the resistance or inductance increases the frequency of interruption which by itself would increase the p.d. at the secondary terminals. But according to Rayleigh this p.d. varies inversely as the square root of the capacity of the secondary circuit; and as the frequency increases the importance of the capacity increases and hence the drop in p.d. Eventually this effect of the capacity reaches a limit, beyond which the direct effect of frequency preponderates; hence there is an ultimate rise in p.d. S. G. S.

525. *Striæ of Oscillating Sparks.* **A. Léauté.** (Comptes Rendus, 148. pp. 339–342, Feb. 8, 1909.)—Kelvin's theory relative to the discharge of a condenser through a self-inductance is not applicable when the coil intercalated in the circuit carries several layers of wire. The author has shown [Abstract No. 1291 (1908) that in the case of two layers the intensity at one of the ends of the coil may be represented by a development of the form—

$$i = \sum_{1}^{\infty}[A_n \sin(2\pi\nu_n\Omega t) + B_n \cos(2\pi\nu_n\Omega t)],$$

in which if Γ represents the capacity of the condenser being discharged, L the self-inductance of the coil, and C its capacity; then $\Omega = 1/2\sqrt{CL}$ and ν_n is the *n*th positive root, taken in increasing order of magnitude, of the equation $h\nu = \cot(\pi\nu)$ in which $h = \pi\Gamma/C$. By the above, certain facts previously observed are explained in detail. By this theory of the discharge of a condenser through a coil carrying two layers of wire, the current which passes through the coil is the sum of two sinusoidal currents. The frequency of the first is practically the same as that given by Thomson's formulæ; the second has a greater frequency, and its existence allows an explanation to be given of all the facts observed relative to striæ in oscillating sparks. A. E. G.

526. *Effect of a Magnetic Field on the Discharge-spark in Condenser Circuits at Atmospheric Pressure and in Vacuum.* **H. Meurer.** (Ann. d. Physik, 28. 1. pp. 199–216, Dec. 28, 1908. Abstract from Inaug.-Dissertation, Strassburg, 1908.)—The first part of the investigation deals with the question whether the discharge potential of a spark-gap can be influenced by a magnetic field, when the spark takes place in the air at ordinary pressure. The answer is in the negative. The method is based upon an arrangement of Mandelstam and Papalexi [see Abstract No. 1277 (1906)] for obtaining high-frequency oscillations differing in phase. f_2 is the spark-gap experimented upon. The light from f_1 is allowed always to fall on it. The p.d. which breaks it down is determined from the phase-difference in the circuits I. and II., and if any difference in this p.d. arises, the phase-difference will change. The phase-difference is determined by Dieckmann's method [Abstract No. 452 (1908)]. A change in the discharge-potential of 0·8 per cent. could have been detected. Magnetic fields of 8,000 to 11,000 gauss were employed. In vacuum, however, a pronounced effect is observed. An air spark-gap in parallel may be used to show the effect. A field of 3,800 gauss gave, when across the spark-gap, an increase in the discharge potential of 18 per cent., and, when along the spark-gap, a decrease of 50 per cent. The impression the author was given was that the phenomenon depends on the action of the magnetic field on the kathode rays and the negative-glow. His experiments give no evidence of a stream of ions leading up to the actual discharge. T. P. B.

527. *Electrical Oscillations in Coupled Circuits.* **E. T. Jones.** (Phil. Mag. 17. pp. 28–48, Jan., 1909.)—When two coupled electric circuits have capacity it is known that in certain cases the system has two free periods of vibration. In this paper the author deals mainly with the case when the oscillations are started by breaking a current in the primary. The value of the secondary potential calculated by Drude's formula is compared with measurements of photographs obtained by means of the short-period electrometer or electrostatic oscillograph described by the author [see Abstract No. 1911 (1907)]. The instrument shows that the course of the variation of the secondary potential is much simpler when the oscillations are started in this way, owing to the absence of disturbance by the auxiliary sparking apparatus. Some photographs and their measurements are also given for electrical oscillations of Duddell currents. The agreement between experiment and theory is most satisfactory. A. R.

528. *Measurements of Damping with Undamped Electrical Oscillations.* **R. Lindemann.** (Deutsch. Phys. Gesell., Verh. 11. 1. pp. 28–34, Jan. 15, 1909. Communication from the Physikal.-Techn. Reichsanstalt.)—A very regular frequency of oscillation is obtained by means of an arc, which burns between the side of a carbon cylinder and the inside of a well-cooled copper tube, into which the carbon cylinder passes. The carbon rod is carefully centred, and the arc is rotated by an axial magnetic field. Resonance is observed in a secondary circuit by a bolometer or thermo-couple arrangement. To get the resistance (r_1) of the secondary, the deflection (a_1) in the bolometer circuit at resonance is observed, then a small known resistance (r_2) in the shape of a short thin wire is added to the secondary circuit, and the deflection (a_2) at resonance observed. Then $\sqrt{a_1} : \sqrt{a_2} = \sqrt{r_1 + r_2} : \sqrt{r_1}$. By making two sets of observations with different coupling the reaction of the secondary on the exciting circuit may be eliminated, when necessary.

T. P. B.

529. *Horizontal Receivers and Transmitters in Wireless Telegraphy.* **H. M. Macdonald.** (Roy. Soc., Proc. Ser. A. 81. pp. 394–397, Dec. 22, 1908.)—A note concerning the theory of the horizontal receiver and transmitter [see Abstract No. 655B (1906)]. Marconi's results confirm theory with regard to length of horizontal part. From a consideration of the combined effect on the detector of the on-coming waves and the induced oscillations in the receiver, it is shown that the curve representing the p.d. in terms of the orientation of the receiver is of the form of the figure 8, with unequal loops, the larger being further from the transmitter. The curve connecting the intensity of the waves radiated from a similar transmitter with its orientation is also of this form. T. P. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

530. *Dielectric Constant near the Melting-point.* **J. Hattwich.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 903–909, June, 1908. From the Physikal. Inst. d. k.k. deutsch. Univ., Prag.)—The author has determined the dielectric constants of the five substances sulphur, paraffin, colophony, naphthalene, phenanthrene at various temperatures by a modification of Drude's method. The primary circuit comprised a spark-gap (in oil) which was connected by parallel wires to a standard plate condenser of variable capacity. The secondary circuit consisted of two parallel wires placed about 20 cm. above the primary, connected at one end, and earthed. At the other end the wires were connected to the coatings of a special cylindrical condenser made of nickel into which was placed the substance to be investigated. A helium tube was fixed across the wires of the secondary circuit near the ends which were not earthed, and the distance apart of the plates of the primary condenser was varied until resonance was obtained. The primary condenser was calibrated by putting into the secondary condenser various mixtures of pure acetone and benzol of known dielectric constant. Having obtained a curve giving the relation between the dielectric constant and the distance between the plates it was possible to investigate the above-mentioned substances. The author finds that, extending his observations over the range 15°–190° C., paraffin has a max. dielectric constant when in the pasty condition (80° C.), whereas phenanthrene has its maximum at a temp. about 10° above its melting-point. Naphthalene, on the other hand, has a minimum constant at its melting-point. W. C. S. P.

531. *The Self-inductance of Two Parallel Wires.* **J. W. Nicholson.** (Phil. Mag. 17. pp. 255–275, Feb., 1909. Paper read before the Physical Soc., June 12, 1908.)—When we have two parallel wires connected in series and carrying alternating currents, the distribution of the current over their cross-section is very irregular if they are close together [see Abstract No. 465 (1908)]. The author discusses the problem of finding the self-inductance per unit length of the wires in this case. By transforming the appropriate Bessel's functions to a new origin he is successful in obtaining solutions sufficiently accurate for most practical problems. For two cylindrical wires of radii a and b respectively he obtains the approximate formula—

$$L = 2\log_e\frac{d^2}{ab} + \frac{2\mu}{x}\,\frac{\operatorname{ber} x \operatorname{ber}' x + \operatorname{bei} x \operatorname{bei}' x}{\operatorname{ber}'^2 x + \operatorname{bei}'^2 x}$$
$$+ \frac{2\mu}{y}\,\frac{\operatorname{ber} y \operatorname{ber}' y + \operatorname{bei} y \operatorname{bei}' y}{\operatorname{ber}'^2 y + \operatorname{bei}'^2 y},$$

where L is the self-inductance per unit length, d the distance between the axes of the conductors, μ the permeability of the metal and $x = 2a\sqrt{(\pi\mu\omega/\rho)}$ and $y = 2b\sqrt{(\pi\mu\omega/\rho)}$; here ω is 2π × the frequency, and ρ is the volume-resistivity of the metal. He points out how to this order of approximation the result might have been written down from known formulæ. For since d^2/ab is in this case assumed to be great, we may assume that the current consists of cylindrical sheets of equal current-density. In this case Russell has shown (*Alternating Currents*, vol. i., p. 56 *et seq.*) that the number of linkages of the lines of force outside the cylinders is $2 \log c^2/ab$ and Heaviside has shown that the number of linkages of the lines of force inside the conductors is given by the next two terms. When the radii of the wires are equal a more accurate formula is obtained. To apply it functions analogous to ber x and bei x derived from the Bessel function of the first order need to be tabulated. A. R.

532. *Short-circuiting of Cadmium Cells.* **P. I. Wold.** (Phys. Rev. 28. pp. 182–185, Feb., 1909.)—The period of short-circuiting varied from 15 sec. to 10 min., and the general shape of the recovery curves is the same in all cases. All the curves indicate complete recovery of the original e.m.f. The internal resistance of the cells is about 1,500 ohms, so that the actual current while short-circuited was rather small. F. E. S.

533. *Theory of the Wiedemann-Franz Law.* **G. Jäger.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 869–878, June, 1908.)—It follows from the electron theory of metals that the ratio of the conductivity of heat to the electrical conductivity is the same for all the metals, and must be proportional to the absolute temperature. Expressions to represent this relationship have been obtained by Drude and also by H. A. Lorentz; the former, however, made the assumption that all electrons possess the same velocity, while the latter assumed a thorough knowledge of the kinetic theory of gases. The present investigation avoids Drude's assumption, and does not require so deep a knowledge as the work of Lorentz assumes. It is assumed that the conduction of heat and electricity is in both cases due to the motion of the negative electrons, and the gas laws apply to these. Their motion may be likened to that of gas molecules in a porous solid, the electrons colliding with the atoms of the metal and with one another. An expression is first found for the electrical conductivity, and then a mathematical investigation of thermal conduction is given. If L = the electrical conductivity and K = the thermal conductivity, then $L = Nle^2/my\sqrt{\pi}$ and $K = 8N\alpha^2 lT/9my\sqrt{\pi}$. Where m is the mass of an electron, l its mean free path, e the atomic charge, N the total number of electrons, y the most probable velocity of the electrons, T the absolute temperature, and α is a natural constant which is the same for all gases and is assumed to apply to electrons. So that—

$$\frac{k}{L} = \frac{8}{9}\frac{Nl\alpha^2 T}{my\sqrt{\pi}} \cdot \frac{my\sqrt{\pi}}{Ne^2 l} = \frac{8}{9}\left(\frac{\alpha}{e}\right)^2 T.$$

This contains no quantity which depends on the nature of the metal, and it is the mathematical expression of the Wiedemann-Franz law. This result is the same as that obtained by Lorentz, but the individual values for K and L obtained by him are 4/3 times larger than those now obtained. A. E. G.

534. *Photo-electric Properties of Potassium-Sodium Alloy.* **J. A. Fleming.** (Phil. Mag. 17. pp. 286–295, Feb., 1909. Paper read before the Physical Soc., Nov. 13, 1908.)—A full account with diagrams is given of the best method for the construction of a suitable vacuum tube for experiments of this kind,

and also the manner of preparing the alloy and introducing it into the tube. When completed the tube consists essentially of a horizontally placed lead glass tube about 50 cm. long and 2 cm. internal diam., having a constriction near the middle of its length. In one end is a piece of Pt-foil attached to two Pt wires fused through the glass, and opposite to this is the alloy, which is brought into electrical connection with the exterior by two other Pt wires. The other end contains the reserve alloy. When the alloy is illuminated by a converging beam of light from the electric arc of a projection lantern equipped with an ordinary condenser lens, and the Pt plate and alloy are connected by wires through a sensitive mirror galvanometer, a current is indicated in the galvanometer circuit, which shows that negative electricity is moving through the vacuum from the alloy to the Pt. Now if metallic Na or K is placed with a Pt plate in a liquid aqueous electrolyte and the circuit completed, there will be a movement of positive electricity from the Na or K through the electrolyte to the Pt. Hence the physical operation of this photo-electric cell is not identical with that of a voltaic cell. The e.m.f. obtained with two such cells was 0·45 volt and 0·6 volt respectively, and when these were placed in series they gave an e.m.f. of 1·0 volt. It is found that the equivalent resistance of such a tube is about 74,000 ohms, on the assumption that the effective e.m.f. is the same when the circuit is open as when closed. Unless a very sensitive galvanometer is used it is necessary to employ an intense beam of light. If the energy required to produce the effect comes from the incident light some must be absorbed, and the active rays must be those absorbed by the alloy, or conversely those emitted by it when heated. Experiments are described to prove that this is probably the case. If the incident light is polarised the galvanometer deflection is much greater when the plane of polarisation is at right angles to the plane of incidence than when these planes coincide; that is, the effect is greatest when the electric vector of the plane polarised light is normal to the surface and least when parallel to it. A great reduction in the galvanometer deflection takes place when a horseshoe magnet is placed with its poles across the tube. The space between the alloy and the Pt will conduct the current from a voltaic cell in one direction only. The effect is increased by heating the alloy, and also by exposing it to powerful radiation for some time. The current is dependent upon the pressure and nature of the residual gas in the tube; in order to obtain the effect well, a very high vacuum is required. The theory that fits in best with the facts is that light facilitates the escape of negative corpuscles from the alloy. The question of photo-electric effects is of interest in long-distance radio-telegraphy. Perfectly dust-free air is not ionised by ultra-violet light. The absorption of long radio-telegraphic waves when they pass through long distances of sunlit air may arise from the photo-electric action of light upon dust particles. If the dust particles absorb ultra-violet light this would account for the small percentage of such light found in sunlight at the earth's surface, for the ionisation found to exist in the atmosphere, and also, perhaps, for the blue colour of the sky. A. E. G.

535. *Compensation Electrometers and Electroscopes.* **Hurmuzescu.** (Annal. Scientifiques de l'Univ. de Jassy, 5. pp. 155–158, Dec., 1908.)—An apparatus is described by which, instead of measuring a fall in potential, as with an ordinary electrometer, or by the divergence of the leaves of an electroscope, the potential is brought back to its initial value by the use of a compensator, the theory of which is as follows: Suppose two concentric

cylinders each of length l, and diameters D and d respectively, then the electrostatic capacity of the system is $C = l/2 \log (D/d)$. If the exterior cylinder is given a charge M at a potential V_0, while the internal cylinder is earthed, the presence of a radio-active body produces in time dt a dispersion $dM = CdV$, and by displacing the interior cylinder a distance dl along the common axis, the capacity is diminished by $dC = dl/2 \log (D/d)$, and the potential correspondingly augmented. The compensator consists of two narrow vertical metallic plates, 2 mm. apart, to the outside of one of which is attached a gold leaf. These are placed in a horizontal cylinder, through the bottom of which a small metallic rod is able to pass up between the two narrow plates. The movement of the rod, which is controlled by a graduated screw-head, is proportional to the divergence of the gold leaf, and the latter is read by means of a microscope with a micrometer eyepiece. With such an apparatus it is easy to read potentials to 0·01 volt. W. H. Si.

536. *Apparatus for demonstrating Rotating Fields.* **G. Bode.** (Deutsch. Phys. Gesell., Verh. 11. 2. pp. 50–52, Jan. 30, 1909. Physikal. Inst. d. Univ., Berlin.)—The apparatus consists of an iron ring overwound with a coil divided into six sections, each covering one-sixth of the surface of the ring; for producing a rotating field, and an apparatus for demonstrating it, opposite sections are connected in series, and the three pairs so formed are connected in star or mesh so as to form a bipolar 3-phase ring. The sections in each phase magnetically oppose each other as regards the iron core, and so produce alternating magnetic fields across the space inside the ring. When connected to 3-phase supply a rotating magnetic field is produced inside the ring. This portion of the apparatus is the same as the well-known rotating field apparatus described in the text-books. The novelty consists in the method of demonstrating the rotating field. A stiff iron wire lying along the axis of the ring and perpendicular to the plane of the ring, carries a bright bead at its free end situated at the centre of the ring, whilst its other end is held in a rigid support. A cylindrical coil of sufficient internal diam. to allow of free transverse motion of the wire, embraces the wire and magnetises it. The length of the wire and its mass are adjusted so that its natural frequency of vibration is equal to the frequency of the 3-phase currents. Then when one phase only is connected to the ring the end of the wire vibrates in the plane of the alternating magnetic field produced by that phase. When three phases are connected the rotating field produced causes the end of the wire to describe a circle, which is rendered distinct by illuminating the bright bead. J. D. C.

537. *Astatic Moving-coil Galvanometers.* **M. Reinganum.** (Phys. Zeitschr. 10. pp. 91–93, Feb. 1, 1909. Physikal. Inst. d. Univ., Freiburg, Dec. 18, 1908.)—The author has rendered moving-coil galvanometers "magnetically astatic" in two ways. In the first method the moving coil carries with it a soft-iron needle, which in the zero position, lies across the lines of the field. Hence in this position it experiences but little induction. When, however, a kick occurs the iron wire becomes magnetised, and so the galvanometer's sensibility is increased. In the second method a magnetised steel needle is attached to the coil so as to lie along the lines of the field when at rest, but in the reverse direction. By this method the author could treble the sensibility of his galvanometer, the zero remaining quite constant and the proportionality of the kicks being unimpaired. E. H. B.

ALTERNATING CURRENTS AND MAGNETISM.

538. *Permanent Magnetism of Copper.* **J. G. Gray** and **A. D. Ross.** (Phys. Zeitschr. 10. pp. 59–61, Jan. 15, 1909. From the English.)—Pure copper has practically no remanence after placing in a strong field at ordinary or liquid-air temperature, nor even if hammered, quenched, or electro-deposited whilst in the field. An ordinary sample of electrolytic copper showed some permanent magnetism, but was found to contain a small quantity of iron. The magnetism was much higher, however, than would be accounted for by so small an amount of iron, unless the existence of the iron in the form of a magnetic compound with copper be assumed. The remanence at liquid-air temperature was in this case about double that at atmospheric temperature. Somewhat similar features were observed in Heusler magnetic alloys, and hence are considered to be properties of copper and not of the magnetic metals. F. R.

539. *Earth Currents.* **B. Brunhes.** (Comptes Rendus, 147. pp. 1445–1446, Dec. 21, 1908.)—For some time past systematic observations of earth currents between places at different altitudes have been made at the principal French mountain observatories. Between Clermont and Puy-de-Dome there is an almost constant p.d. of about 1·70 volts, with Clermont as the positive pole. The stations are distant horizontally 10 km., and differ in altitude by 1,100 m. There is a slight indication of a faint maximum about 11h. a.m., but this requires further examination, as most of the work has to be done during the night on account of the line being required for telegraphy in daytime, and also because the electric tramways interfere. At the Pic-du-Midi, however, where the line is directed north and south, the earth current shows a great diurnal variation. At Tortosa the current goes from west to east, whereas between Clermont and Puy-de-Dome it goes from east to west, and is nearly three times as strong at the latter station compared with Tortosa, suggesting a variation with altitude. C. P. B.

540. *Solar Magnetic Fields and Terrestrial Magnetism.* **W. Sutherland.** (Terrestrial Magnetism, 13. pp. 155–158, Dec., 1908.)—The author considers the effect of the discovery of Hale's sun-spot magnetic field [see Abstracts Nos. 1586, 1587 (1908), and 30 (1909)] on the general theory of solar magnetism. Taking a concrete instance, we have a solar vortex of 140,000 km. radius, velocity 106 km. per sec., with a magnetic field of 10,000 gauss along the axis of rotation, while the earth, of radius 6,370 km., rotating once in 24 hours, has a magnetic field whose strength indicated by the vertical force at the poles averages 0·66. Applying the formula developed by the author some years ago connecting magnetism and gravitation, it appears that the rotation of the spot material in the vortex accounts for only about $\frac{1}{38}$th part of the observed max. magnetic field in the spot regarded as near the centre of rotation. A suggestion is given that, as in the case of the earth, the sun-spot vapours may carry the neighbouring ether with them, and this would considerably modify the analysis, bringing the two results into much closer agreement. C. P. B.

REFERENCES.

541. *Electromagnetic Mass of Electron.* **F. Hasenöhrl.** (Akad. Wiss. Wien, Sitz. Ber. 117. 2a. pp. 691–697, May, 1908.)—Treats by a new method the problem of finding expressions for the electromagnetic energy and mass of an electron, and finds results in accord with those already established. E. H. B.

542. *Ratio e/m for Mercury Vapour.* **R. Pohl.** (Phys. Zeitschr. 10. p. 90, Feb. 1, 1909. Physikal. Inst. d. Univ., Berlin, Dec., 1908.)—Commenting upon the recent endeavour of R. Fürstenau to determine the above ratio by a new method [see Abstract No. 107 (1909)], the present author denies that any new method is therein brought forward. E. H. B.

543. *Movement of Free Electrons in Metals.* **P. Gruner.** (Phys. Zeitschr. 10. pp. 48–51, Jan. 15, 1909.)—A mathematical discussion of the subject. Expressions for specific electric conductivity, specific conductivity for heat, contact p.d., thermo-electric e.m.f. and the heat generated in a wire carrying a current are deduced from the fundamental formulæ developed for the motion of electrons in metals. A. W.

544. *Mechanical Action due to a Filiform Current Flux.* **Levi-Civita.** (Accad. Lincei, Atti, 18. pp. 41–50, Jan. 17, 1909.)—The paper is entirely mathematical, and in it is obtained a new expression for the mechanical force upon a current when this is in the form of an indefinitely thin tube. S. G. S.

545. *Theory of Lightning.* **D. S. Carpenter.** (Electrical World, 53. pp. 111–113, Jan. 7, and pp. 158–161, Jan. 14, 1909.)—A theory of the production of high potentials in the atmosphere by the coalescence of small drops into larger ones, and these again into cloud masses, is put forward in the first article. The induced charges on the surface of the earth by the clouds is then considered in the second paper. E. H. B.

546. *Vacuum-tube Model for Demonstrating the Propagation of Alternate Currents in Cables.* **C. V. Drysdale.** (Phil. Mag. 16. pp. 718–720, Nov., 1908. Paper read before the Physical Soc., March 27, 1908.)—Full description of the apparatus mentioned in Abstract No. 280B (1908).

547. *Use of High-frequency Apparatus.* **F. Dessauer.** (Phys. Zeitschr. 10. pp. 52–53, Jan. 15, 1909. Elect. Rev. 8. West. Electn. 54. p. 449, March 6, 1909. Abstract.)—The secondary output of a high-frequency apparatus, employing an Oudin type resonator, is said to be much increased by using two symmetrically placed spark-gaps in the exciting circuit (comprising auto-transformer primary turns) in place of the single one generally employed. L. H. W.

548. *Influence of Moisture on Electrical Properties of Selenium.* **C. Ries.** (Phys. Zeitschr. 9. pp. 569–582, Sept. 1, 1908.)—According to the author, the discrepancies between the observations of different investigators may be explained by taking into account the presence or absence of moisture in the experimental selenium. [See also Abstract No. 1294 (1908).] D. H. J.

549. *Electrocapillary Phenomena in Gases.* **G. Reboul.** (Comptes Rendus, 148. pp. 221–223, Jan. 25, 1909.)—Mercury and an ionised gas act as do mercury and acidulated water in a Lippmann's capillary electrometer. There are indications of a double layer at the surface of contact between the metal and the gas. A. D.

550. *Magnetic Polar Storms and Auroræ.* **K. Birkeland.** (Comptes Rendus, 148. pp. 30–33, Jan. 4, 1909.)—The author gives more photographs of his magnetised ball subject to kathode discharge for illustrating magnetic storm phenomena. Very characteristic luminous spirals are seen round the poles, and are suggestive of the auroral rings seen during terrestrial magnetic storms. [See Abstract No. 2027 (1908).] C. P. B.

551. *Relativity and Electron Theory applied to Moving Bodies.* **P. Frank.** (Ann. d. Physik, 27. 5. pp. 1059–1065, Dec. 15, 1908. Physikal. Inst. d. Handelshochschule, Berlin.)—A highly mathematical paper in which the author derives the fundamental equations of the electromagnetic phenomena in moving ponderable bodies from the principle of relativity and the electron theory. E. H. B.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

552. *New Element allied to Molybdenum.* **M. Ogawa.** (College of Science, Imperial Univ., Tōkyō, Journ. 25. Article 16. Chem. News, 98. pp. 261–264, Nov. 27, 1908.)—Both molybdenite and thorianite contain another new element [see Abstract No. 2089 (1908)], closely allied to Mo, and probably identical with the "new tin-group element in thorianite" described by Miss Evans (Chem. Soc., Journ. 93. pp. 667–668, 1908). The element has an equivalent of about 16·7 and forms two oxides, the higher one being acidic in character and resembling molybdenum trioxide, and the lower one, in a hydrated condition, having a graphitic appearance. When heated in a current of hydrogen both the oxides yield the metal, which does not fuse at a red heat, but burns brilliantly in the air, giving the higher oxide. Besides this new element and "nipponium" [Abstract No. 2089 (1908)], thorianite appears to contain still another new element, the oxide of which is radio-active and dissolves in nitric acid to a bluish-green solution.

T. H. P.

553. *Atomic Decomposition and Spectral Series.* **A. L. Bernoulli.** (Phys. Zeitschr. 9. pp. 745–749; Discussion, pp. 749–750, Nov. 1, 1908. Paper read before the 80. Naturforscherversamml., Köln.)—The author regards atomic and molecular weights of gases as representing only average values, the atoms and also the molecules of a gas being variable. Assuming that any gaseous element consists of an equilibrated mixture of polymerised forms of a primordial substance, the author deduces the following formula for calculating the atomic weights of the elements :—

$$A = 1{\cdot}0104[(-1-\sqrt{8})/2]^p[(-1+\sqrt{8})/2]^q,$$

p and q being integers. Taking different values for p and q, this formula gives atomic weights in good agreement with the experimental numbers. A formula is also deduced which gives the lines and bands in the spectra of the elements, the agreement with observation being close. T. H. P.

554. *Cooling and Liquefaction of Gases.* (D.R.-P. 198,508 of 1907. Zeitschr. Elektrochem. 14. pp. 785–786, Nov. 27, 1908. Abstract.)—In liquefying gases of low boiling-point (air), G. Hildebrandt applies a mixture of that gas with another gas of higher boiling-point (CO_2), in order that the latter gas, which condenses first, should facilitate the liquefaction of the former by its own evaporation. In practice it will not, as a rule, be necessary to prepare a mixture of the two gases; it suffices if the CO_2 already contained in the air be not removed. The gas mixture (air) passes from the cooled compressor through a coil in which the CO_2 is liquefied; the re-evaporated CO_2 cools this coil and escapes into the atmosphere, or is taken back to the suction-pipe of the compressor. The uncondensed gas passes through the lower portion of the coil and is then allowed to expand; part of the gas is liquefied, another part cools the lower portion of the coil. H. B.

555. *Two Electrical Furnaces.* **K. Friedrich.** (Metallurgie, 5. pp. 703–705, Dec. 8, 1908. Communication from the Metallograph. u. Metallurg.

Laborat. d. Kgl. Bergakademie, Freiberg.)—Two types of small laboratory furnaces are described. In the first the resistor is an iridium tube with platinum flanges at the ends, surrounded by refractory material. A temperature of about 1,600° C. is reached within half a minute, with a tube of 100 mm. effective length, 1·7 mm. diam., 0·4 mm. thick, and a current of 900 to 1,000 amps. at about 8 volts. The second furnace is of the Pt-wire resistance type, and will hold a crucible of the same size that would be taken by the first furnace. The Pt is wound on a clay tube. 1,200° to 1,800° C. is reached within half an hour with 2 to 2½ amps. at 220 volts. Both furnaces are specially designed to facilitate the use of a neutral atmosphere. The first is particularly intended for rapid heating or high temperatures, the second as an improvement on the kryptol resistor type in regard to uniformity of heating. F. R.

556. *Silicothermic Experiments.* **P. Askenasy** and **C. Ponnaz.** (Zeitschr. Elektrochem. 14. pp. 810–811, Dec. 11, 1908. Inst. f. phys. Chemie u. Elektrochemie d. techn. Hochschule, Karlsruhe.)—Once the reaction between mixed silicon powder and barium peroxide is started, it proceeds with violence if the powders be fine, but can be controlled by using coarser powders. Using 8 parts Si and 100 BaO_2, the result was silicate which was completely volatilised. With 80 Si and 100 BaO_2 a silicide containing 80 per cent. Ba was obtained. Iron was readily melted, using 2 kg. of BaO_2, 80 gm. of sodium peroxide, 175 gm. Si, and 1·4 kg. of iron filings. The button of iron was still soft showing that it had not taken up much Si. Copper and other metals can be melted and alloyed, and oxides, *e.g.*, Cr_2O_3, reduced by means of Si. Ferro-silicon or a mixture of ferro-silicon with iron may be used in place of Si. A titanium silicide of about the composition Ti_2Si_3 was formed by heating together titanic acid and Si, and was similarly used in place of Si in melting iron, but gave a hard ferro-titanium. The 90 per cent. Si used costs about 4d. per lb. F. R.

557. *Siliceous Clays in Aluminium Manufacture.* **M. Moldenhauer.** (Metallurgie, 6. pp. 14–19, Jan. 8, 1909. Communication from the Inst. f. Metallhüttenw. u. Elektrometall. d. Kgl. techn. Hochschule, Aachen.)—Negative or poor results were obtained in attempts to extract alumina from silicate clays by heating in the electric furnace in theoretical proportions to give (*a*) Fe_2Si and Al_2O_3CaO by addition of hæmatite, CaO and C; (*b*) $Al_2O_3FeO(SiO_2)_2$; (*c*) Al_2O_3CaO and SiC; (*d*) $Al_4C_3 4SiC$. (*d*) was more promising than the others; so also was (*e*): $Al_2O_3 2(SiO_2 2FeO)$, but on heating this silicate with carbon under zinc vapour no Al was obtained. Therefore the method was pushed as far as possible in the direction of giving a high-percentage ferro-silicon as by-product. The limit in practice appears to be reached with $3(Al_2O_3, 2SiO_2) + Fe_2O_3 + 15C = Al_2O_3 + 2FeSi_3 + 15CO$. Trials were made to ensure that the resulting Al_2O_3 could conveniently be reduced in the ordinary way by electrolysis in molten cryolite. The melting-point diagram for cryolite-alumina was redetermined, and the author finds a minimum at 880° with 20 per cent. Al_2O_3, and a eutectic at 898° with from 25 to 50 per cent. Al_2O_3. F. R.

558. *Structure of Hardened Steel.* **W. J. Kurbatoff.** (Metallurgie, 5. pp. 721–728, Dec. 22, 1908. Communication from the Chem. Laborat., St. Petersburg Univ.)—Micrographic study of quenched samples leads to the following conclusions: The best method of obtaining austenite consists in

quenching steel containing from 1·8 to 2·2 per cent. carbon in mercury at 180°. The constituent, needles of which pierce the austenite crystals, is troosto-sorbite. Troostite forms a network round these grains. Upon tempering, austenite is converted into sorbite and troosto-sorbite, and sorbite into pearlite, but the changes—austenite $\longrightarrow$ martensite $\longrightarrow$ troostite $\longrightarrow$ sorbite do not occur. The reaction austenite $\rightleftarrows$ sorbite takes place from right to left at from 90° to 150° and above 1,000°. At the lower temperatures the network of troostite affects the progress of the reaction. Between 150° and 750° the reaction occurs in the opposite sense, with a max. speed at 250°. The dark-coloured constituent must contain both troostite and sorbite, which upon heating change respectively into cementite (or ferrite according to the carbon content) and pearlite. It is probable that austenite is a carbide of iron having a formula between Fe_6C and $Fe_{10}C$, say about Fe_7C. Troostite and sorbite are solid solutions of C in αFe or βFe. F. R.

559. *Effect of Manganese on the Iron-Carbon System.* **F. Wüst.** (Metallurgie, 6. pp. 8–14, Jan. 8, 1909. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—The author's study of 42 alloys containing from 4 to 6·9 per cent. carbon and 0 to 80 per cent. Mn, with respect to critical points in their cooling curves, and to microstructure, leads to the following conclusions: With addition of Mn up to 18 per cent. the solidification temperature of cast iron is lowered, and with further addition of Mn rises to 1,250° with 80 per cent. Mn. The eutectic with 15 per cent. Mn contains 4·05 per cent. carbon, and solidifies at about 1,120°. The solvent power of Fe for C is raised by addition of Mn; upon quenching alloys containing 50 per cent. Mn sufficient carbon is retained in solution for the formation of $(Fe,Mn)_3C$. The addition of Mn lowers the temperature of formation of pearlite considerably, and with more than 5 per cent. Mn the pearlite point vanishes altogether in these high-carbon alloys. The lag of the pearlite point is increased by the addition of Mn, and the tendency is to form troostite, or with higher Mn for the solid solution of carbide in γ-iron to remain untransformed. F. R.

560. *Identification of Steels from Sparks on Grinding.* **M. Bermann.** (Zeitschr. Vereines Deutsch. Ing. 53. pp. 171–178, Jan. 30, 1909.)—The characteristic types of sparks obtained on grinding various steels on an emery wheel are shown, for which the original should be consulted. The sparks are minute specks of glowing metal, which at one part of their trajectory suddenly glow white-hot and burst. This explosion the author explains thus: The surface oxidation of the speck furnishes the major portion of the heat, and the metal within fuses. CO_2 is formed by the combination of the carbon of the steel with oxygen from the oxide, and this bursts the crust of oxide with a minute explosion. Larger particles are less liable to fusion. These conclusions were deduced from microscopic examination of specks *in situ* as collected on a glass plate. Some practical applications of the method are suggested. [See Demozay, Abstract No. 2787B (1904).] F. R.

561. *Hardening and Tempering of Steel.* **E. Maurer.** (Metallurgie, 6. pp. 33–52, Jan. 22, 1909. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—The author's experiments lead to the following results: The changes brought about by quenching pure iron can all be explained by regarding the piece as consisting of cold-worked α iron. Cold working has the same effect upon steel as quenching, though to a much

less degree, as shown by the similarity of the curves of hardness in relation to tempering temperature. Homogeneous austenite can be obtained by the usual procedure for obtaining the austenite-martensite mixture, provided the steel contains sufficient Mn. The transition temperature of austenite depends on the percentage of Mn present, and generally speaking increases with it. With low Mn, austenite changes into troostite at 150°–250° C., but at even lower temperatures the martensite has already begun to break down. During cooling austenite is converted into martensite. The alterations of physical properties (hardness, magnetic remanence, density, electrical conductivity) as well as microstructure, all confirm the 150°–250° change. The conductivity depends on the amount of hardening carbon; density and hardness are correlated with the magnetic properties. In general the whole range of tempering and softening may be divided into four periods: (1) up to 150°, hardening carbon, and its dependent property, electrical resistance, fall; (2) 150°–300°, conversion of γ iron into deformed β and α iron, accompanied by fall in density, and change in all other properties; (3) 300°–450°, conversion of β iron into deformed α iron, which gradually crystallises; (4) 450° to Ac_m crystallisation of the deformed α iron and polymerisation and agglomeration of the carbide. Numerous curves and photomicrographs are given.

F. R.

562. *Silicon-Silver Alloys.* **G. Arrivaut.** (Comptes Rendus, 147. pp. 859–861, Nov. 9, 1908. Zeitschr. Anorg. Chem. 60. 4. pp. 436–440, Dec. 19, 1908.)—A determination of the solidification diagram for this system leads to the conclusion that there is a eutectic with about 5 per cent. Ag, solidifying at about 830°. Although the cooling-curve work indicated that Si up to 10 per cent. goes into solid solution in Ag, yet the existence of the solid solution in the 50 per cent. sample was not confirmed. In the 40 to 60 per cent. Si samples the eutectic was expressed by expansion of the Si-rich constituent during solidification, and an analysis showed it to contain Si 4·80, Ag 94·85 per cent.

F. R.

563. *Magnesium-Silicon Alloys.* **R. Vogel.** (Zeitschr. Anorg. Chem. 61. 1. pp. 46–58, Jan. 4, 1909. Metallog. Communication from the Inst. f. physikal. Chemie d. Univ., Göttingen.)—The Si used contained 7·8 per cent. of impurities, but for purposes of comparison three alloys (including the Mg_2Si) were made from pure Si. Si and Mg are miscible in all proportions in the liquid, and give rise to the compound Mg_2Si, corresponding to a maximum at 1,120° C., and two eutectics, Si—Mg_2Si (containing 42 per cent. Mg), and Mg_2Si—Mg (containing 96 per cent. Mg), corresponding to minima at 950° C. and 645° C. respectively. No solid solutions are formed in this series. The microstructures of the alloys are described, and the paper illustrated by six micrographs.

F. C. A. H. L.

564. *Platinium-Antimony Alloys.* **K. Friedrich and A. Leroux.** (Metallurgie, 6. pp. 1–3, Jan. 8, 1909. Communication from the Metallograph. u. Metallurg. Laborat. d. Kgl. Bergakad., Freiberg.)—The temperature-concentration diagram for the series from 0 to 91·8 per cent. Pt is given, with photomicrographs of some of the alloys. A maximum in the liquidus occurs at about 1,226° corresponding to the composition $PtSb_2$. From 0 to 44·7 per cent. Pt pure or nearly pure Sb is one of the constituents. With higher Pt content, PtSb or possibly a solid solution of $PtSb_2$ in Pt is formed, but again decomposes on cooling. A eutectic—probably Pt : solid solution of PtSb or

$PtSb_2$ in Pt—containing about 76 per cent. Pt solidifies at 684°. This is decomposed by slow cooling near the 640° transition-point, apparently with formation of Pt_5Sb_2. F. R.

565. *Alloys of Silicon with Tin, Lead, and Thallium.* **S. Tamaru.** (Zeitschr. Anorg. Chem. 61. 1. pp. 40–45, Jan. 4, 1909. Metallog. Communication from the Inst. f. physikal. Chemie d. Univ., Göttingen.)—The silicon used contained 92·48 per cent. Si, and solidifies at 1,383° C., as against 1,417° C. for pure silicon, which was used in making alloys containing over 90 per cent. Si for purposes of comparison. Silicon and tin are miscible in all proportions in the liquid, but form neither compounds nor solid solutions. Tin decreases the solidifying-point of Si, but only very slowly at first; the alloy containing 90 per cent. Sn solidifies at 1,256° C., after which the decrease is very rapid. With Pb and Tl, Si is immiscible both in the liquid and solid states; and no compounds are formed in these series. F. C. A. H. L.

566. *Nickel and Phosphorus.* **N. Konstantinow.** (Zeitschr. Anorg. Chem. 60. 4. pp. 405–415, Dec. 19, 1908.)—Contains the results of thermal and microscopic examination of the combinations of Ni and P. For the preparations pure Ni and a rich phosphor-nickel are melted together. The phosphor-nickel is prepared by heating a mixture of finely-divided Ni and dry red phosphorus very slowly in a graphite crucible and introducing into the molten mass small tubes of graphite or asbestos, filled with phosphorus. By this means 28 per cent. of P (by weight) may be introduced. During the cooling the melt is covered with $BaCl_2$ to prevent oxidation. The results of the pyrometric observations up to 35·6 atomic per cent. of P denotes the existence of 4 stable phases in this system. At 19 atomic per cent. P a eutectic occurs with a melting-point of 880°: a compound Ni_3P is indicated which is only stable below 960°. With 28·8 atomic per cent. P a temperature maximum is obtained at 1,182° corresponding to the compound Ni_5P_2; this compound has, when fractured, a fine crystalline structure and yellow colour; it exists in two modifications: the β, stable at high temperatures, changes into α at 1,025°. A third compound Ni_2P is also indicated. Between 29 and 33 atomic per cent. P a second eutectic line is present at a temperature of 1,107, the eutectic composition being 32·2 atomic per cent. P. With more than 33 per cent. P a strong burning off of the phosphorus begins; this burning ceases with the separation of the primary crystals, but again commences on cooling down to a second halt-point which occurs at 830°. C. O. B.

567. *Structure of Bronze Coinage during Manufacture.* **F. Giolitti and E. Pannain.** (Accad. Lincei, Atti, 17. pp. 668–670, Dec. 6, 1908.)—The metal used in the Mint at Rome contains 3·82 per cent. Sn, 95·8 per cent. Cu, and 0·38 per cent. impurities, and is first moulded in rectangular bars, about 40 cm. long, 7–8 mm. thick, and 3·5 to 5·5 cm. wide, according to the diam. of the coin required. These, after being heated to redness and rapidly cooled by immersion in running water, are repeatedly heated to dull redness and subjected to pressure, till a thickness of 1·5, 1 or 0·7 mm. is obtained, these thicknesses corresponding to 10-, 5-, and 2-centesimi pieces respectively. Photomicrographs are given of a sample at various stages of treatment showing that its initial constitution, which consisted of a solid solution α, of heterogeneous concentration, in which are scattered crystals of a solid solution β, remained unaltered throughout the entire treatment.

Metal of this composition should consist of mixed crystals *a* only, and the presence of the solid solution β is attributed to the rate at which the alloy was originally cooled—a factor which must have considerable influence on the subsequent working of the metal. W. H. St.

568. *Effect of Quenching Aluminium Bronze and Muntz Metal.* **E. S. Sperry.** (Mech. Eng. 23. pp. 156–157, Feb. 5, 1909. From "The Brass World.")—The tensile strength of aluminium bronze can be increased by from 15,000 to 20,000 lbs. per sq. in. by quenching, without substantially affecting the ductility. Results for Muntz metal are also given, but do not bear out the statement that quenching increases the tensile strength. The fracture of the quenched aluminium bronze is coarsely crystalline, and it is to be expected that ingots destined to be rolled will be less liable to crack if not first quenched.

Percentage Composition.				Deg. F.	Tensile Strength, lbs. per sq. in.	Elongation per cent. on		Contraction per cent.
Copper.	Aluminium.	Zinc.				1 in.	8 in.	
90	10	—	As rolled......	—	71,050 to 76,400	9 to 14	7·2 to 10·6	11 to 15
			Annealed at ..	1,300°–1,350°	66,600 to 73,600	18 to 22	15·3 to 18·5	17 to 18
			Quenched from	1,330°–1,350°	97,610 to 89,720	18 to 26	12 to 17·1	14 to 19
60·51	—	38·66	As rolled......	—	64,060	53	26·6	50·4
			Annealed at ..	1,220°	56,330	70	49·2	50·9
			Quenched from	1,220°	61,120	29	27·7	29

F. R.

569. *Tellurides of Arsenic and Bismuth. Cryoscopic Constant of Tellurium.* **H. Pélabon.** (Comptes Rendus, 146. pp. 1397–1400, June 29, 1908.)—*Arsenic and tellurium* form the compound As_2Te_3 whose solidification temperature 362° is a maximum on the concentration-solidification temperature curve. With 8 atoms of Te and 1 atom of As there is a minimum solidification temperature of 329°, and another minimum, 355°, for the composition 9As + 11Te. For the composition As + Te, or with further addition of As, the solidification occurs at 358°; thus probably As beyond this proportion is not dissolved. *Bismuth and tellurium* form the compound Bi_2Te_3 solidifying at 583°. There are two eutectic minima, 15 per cent. Bi (410°), and 99 per cent Bi (263°). The cryoscopic constants, K, of each of these and other tellurides are as follows:—

	As_2Te_3.	Bi_2Te_3.	SnTe.	Ag_2Te.	PbTe.	Sb_2Te_3.
K.........	517	528	510	535	515	517

The mean value of K is about 520. Using the relations (1) $wL/T\sqrt[3]{v} = \text{const.}$ which gives the latent heat, L, of tellurium as 20 to 21 cals., and (2)

$K = 0{\cdot}02T^{3}/L$, we have K from 500 to 515, which agrees well with the above figures deduced from the experimental results. ω is atomic weight, T melting-point absolute, v atomic volume. F. R.

570. *Direct Union of Carbon and Hydrogen.* **W. A. Bone** and **H. F. Coward.** (Chem. Soc., Journ. 93. pp. 1975–1993, Nov., 1908.)—The early work of one of the authors and of Pring and Hutton is discussed, and the results of Mayer and Altmayer and their conclusions are criticised. A series of experiments were then made in which a known weight of carefully purified sugar carbon was heated to 1,000–1,150° C. in a porcelain tube in a current of hydrogen and the resulting gases collected and sampled. The samples were then subjected to a preliminary concentration to remove the excess of hydrogen. This was effected by absorbing the hydrogen by Pd-foil. In this way about a litre of the mixed gases was concentrated to from 20–50 c.cm. which was then analysed, by explosion with oxygen. The weight of carbon employed was 0·0247, 0·0995, and 0·092 gm. in three experiments. In two experiments, one at 1,150° and one at 1,120–1,130° C., the yield of methane was 78 per cent. of that theoretically obtainable, in a third it was 61 per cent. of the theoretical yield. The authors consider that the direct union of carbon and hydrogen to form methane is proved beyond question.

F. J. B.

571. *Osmotic Pressure of Aqueous Solutions of Calcium Ferrocyanide. Part I. Concentrated Solutions.* **Berkeley, E. G. J. Hartley,** and **C. V. Burton.** (Roy. Soc., Phil. Trans. Ser. A. 209. pp. 177–208, Nov. 23, 1908.)—Measurements have been made of (1) the density, (2) the compressibility, (3) the vapour pressure, and (4) the osmotic pressure of aqueous solutions of calcium ferrocyanide at concentrations ranging from 30 to 50 gm. of the anhydrous salt to 100 gm. of water. The equation given by Porter [Abstract No. 356 (1908)] for the osmotic pressure of concentrated solutions involves all these quantities, and gives a fair agreement with the observed equilibrium pressure; but closer agreement was obtained with a modified equation, in which allowance is made for the presence of the atmosphere in the various operations—

Concentration.	Obs. Equilibrium Pressure.	Porter's Equation gives	Modified Equation gives
49·966	130·66	135·04	131·45
47·219	112·84	116·05	112·96
42·889	87·09	88·99	86·61
39·503	70·84	72·54	70·61
31·388	41·22	42·38	41·24

The methods used for measuring osmotic pressure were identical with those already described, but important improvements have been made in the method of determining vapour pressures, especially by eliminating mercury joints (and so removing errors due to evaporation and condensation of mercury) and by narrowing the connecting tubes so as to avoid condensation of moisture in them. The apparatus for measuring compressibilities is also new, and appears to have given very satisfactory results. T. M. L.

572. *Cadmium Amalgams.* **G. A. Hulett** and **R. E. De Lury.** (Amer. Chem. Soc., Journ. 30. pp. 1805–1827, Dec., 1908.)—An account of an investigation of some of the properties, more especially the e.m.f., of very dilute

cadmium amalgams. As a constant reproducible electrode, a two-phase cadmium amalgam was used, and experiments on this and other amalgams showed that, if p is the percentage composition of a cadmium amalgam, the density at 25° C. is given by $D = 18{\cdot}5340 - 0{\cdot}0606p$, and the decrease in density per degree is $-(0{\cdot}0024 + 0{\cdot}0003p)$. The measurements of e.m.f. extended from the saturated amalgam to a dilution of one part of cadmium in one hundred million of mercury, the two-phase amalgam always forming one electrode and the dilute amalgam the other. The results are given in the following table. In col. 2 the observed e.m.f. is given and in col. 4 the e.m.f. calculated from the Nernst relation for concentration cells:—

Amalgam.	Observed e.m.f.	Differences.	Calculated e.m.f.
5·902/100	0·000000		—
4/100	0·005366	0·005366	0·005580
2/100	0·014445	0·009079	0·014480
1/100	0·023375	0·008930	0·023380
1/1000	0·052940	0·029565	0·052940
$1/10^4$	0·082540	0·029600	0·082500
$1/10^5$	0·112100	0·029560	0·112060
$1/10^6$	0·141600	0·029500	0·141620
$1/10^7$	0·173200	0·031600	0·171180
$1/10^8$	0·22	0·046800	0·200740

It is concluded that in the region between 1 of cadmium to 100 of mercury and 1 of cadmium to 1,000,000 of mercury the p.d. of any two amalgams corresponds to the requirements of the gas laws. A deviation from these requirements is found for amalgams containing less than 1 of cadmium to 1,000,000 of mercury. This deviation was anticipated and is interpreted as evidence in favour of the reversibility of the reduction of mercury by cadmium, indicating that this reaction does not go to completion, but that a definite equilibrium is established. F. E. S.

573. *New Galvanic Chains with Solid Electrolytes.* **R. Beutner.** (Centralblatt Accumulatoren, 9. pp. 153–154, Oct. 20, 1908. Extract of Dissertation, Karlsruhe, 1908.)—The electrolytes are solidified salts which do not diffuse into one another, contained in U-tubes of glass or other materials and heated in them. A mixture of Na_2SO_4 and K_2SO_4 is, for instance, fused in a U-tube of glass with unequal limbs; after the salt has solidified, NaCl + KCl and AgCl containing an electrode of silver are brought into the long limb, and Ag_2SO_4 and a silver electrode into the other; the e.m.f. of this chain ranges from 0·514 to 0·528 volt at different temperatures. When Na_2SO_4 alone is to be used, which has a higher melting-point than glass, a tube of quartz is applied, or the salts—previously fused and broken up into grains—are compressed in a steel cylinder with the aid of a screw [compare Lorenz and Katayama, Abstract No. 1216 (1908)]. A compressed chain of $-Ag \mid AgCl \mid NaCl \mid Na_2SO_4 \mid Ag_2SO_4 \mid Ag+$ gave 0·549 volt at 275° C. and 0·570 volt at 406° C. Salts having one ion in common with the adjoining two salts may be interposed without affecting the e.m.f. The author tried a great many other combinations with salts of Li, Pb, Cd, Sr, F, &c., and also crystallised solutions, and finds the e.m.f. more or less in agreement with Thomsen, Berthelot, and others. H. B

574. *Piezo-chemical Studies.* **E. Cohen** and **L. R. Sinnige.** (Zeitschr. Elektrochem. 15. pp. 76–77, Feb. 1, 1909. Van't Hoff Laborat., Utrecht, Dec., 1908.)—From theoretical considerations both Willard Gibbs and Duhem have deduced that in a reversible cell the alteration of e.m.f. is proportional to the pressure, when $(dV/de)_T$ is constant, where dV is the alteration in volume which takes place in the cell when the quantity of electricity de flows through it at the temperature T. The authors find this to be the case with the combination Cd/solution $CdSO_4$/12·5 per cent. by weight Cd amalgam, at 25° C., the values of dE/dp being 0·0000196–0·0000198 for pressures up to 1,000 atmos., where E is the e.m.f. in volts and p the pressure in atmos. T. S. P.

575. *Decomposition of Carbon Dioxide by the Silent Electric Discharge.* **A. Holt.** (Chem. Soc., Journ. 95. pp. 80–84, Jan., 1909.)—Carbon dioxide, carefully dried by phosphoric oxide, is decomposed by the silent discharge to an extent which increases as the pressure of the gas diminishes and reaches 48 per cent. at 80 mm. pressure, but only 8 per cent. under 700 mm. pressure. The amount of decomposition varies also with the degree of dryness of the gas, the intensity of the discharge, and the form of ozoniser employed. Moist CO_2 decomposes, however, to a larger extent as the pressure of the gas increases, ranging from 8 per cent. under 50 mm. pressure to about 14 per cent. under 700 mm. pressure. The weaker the discharge the less the amount of gas decomposed at all pressures. Comparison of these results with those obtained when moist and dry CO_2 is decomposed by ultra-violet light or by induction sparks leads to the conclusion that the silent discharge at low pressures acts chemically, mainly like ultra-violet light, whilst as the pressure of the gas increases the discharge behaves more and more as though it consists of actual sparks. T. H. P.

576. *Products of Arc and Spark Discharges in Liquid Argon (and Nitrogen).* I. and II. **F. Fischer** and **G. Iliovici.** (Ber. Deut. Chem. Gesell. 41. pp. 3802–3810, Nov. 7, and pp. 4449–4457, Dec. 29, 1908. Chem. News, 99. p. 88, Jan. 22, 1909. Abstract.)—According to W. Ramsay and to Kohlschütter argon seems to be capable of forming endothermic compounds which are decomposed again at very high temperatures, but might be preserved by sudden covering, as in the formation of ozone in liquid oxygen. The argon was isolated from air by means of calcium carbide (mixed with 10 per cent. of $CaCl_2$) at 800° C. in an iron tube (Ber. Deut. Chem. Gesell. 41. pp. 2017–2030). The arc and spark experiments are performed with Cd electrodes (chosen on account of Kohlschütter's experiments); the arcs of 220 volts and 0·4 amp. were very unsteady. Sparking for 8 hours in liquid argon gave 8·3 mgm. of an olive-green substance, the arc in 140 min. 22·7 mgm. of a black substance. The former was probably essentially cadmium nitride, the latter this nitride mixed with Cd. The nitrogen must have been due to infiltration of air or impurity of the argon, whose density was 19·94. Heated in a vacuum the compounds yield a gas, essentially N_2; with acids ammonia is evolved. The spectrum of the gas, examined in vacuum bulbs with Al electrodes, showed first lines of N, H, Cd and Hg; when the nitrogen was bound by phosphoric acid, the red argon lines appeared at once; they are not masked at 0·1 mm. of Hg by any nitrogen present unless the nitrogen percentage rises above 4. The bulbs gradually became "hard" and the nitrogen lines vanished, leaving only the argon and hydrogen. The argon is probably adsorbed by the nitride. In the second paper the silent discharge was sent, in electrodeless tubes, through pure hydrogen, argon, and mixtures of the two gases at pressures of 8, 0·8, 0·08 mm. of Hg; no volume-changes suggesting molecular combination were observed. New forms of electrodeless bulbs are described: bulbs connected by a narrow tube, the bulbs being coated outside with metal and enclosing other glass bulbs, silvered inside and filled with powdered copper; these bulbs give currents of higher density. Other experiments with electrodes of Ti, Sn, Sb, Pb, Bi (as in the first-mentioned case) yielded, in addition to metal, some nitride; heated in a vacuum, these nitrides of Sn, Pb, Sb, Bi give N_2, treated with acids they yield ammonium salts. The titanium electrodes crumbled without volatilising. H. B.

577. *Tubular Ozone Apparatus.* VII. and VIII. (1) *Determination of the Power Factor.* (2) *Ozone Production from Oxygen and from Air.* **E. Warburg** and **G. Leithäuser.** (Ann. d. Physik, 28. 1. pp. 1–16, and pp. 17–36, Dec. 28, 1908. Communication from the Physikal.-Techn. Reichsanstalt.)—An Ozone apparatus of the Siemens type, consisting of two concentric tubes, can be regarded as a multiple, cylindrical condenser of infinite length, the glass surfaces, acid or metal forming the coatings, and the glass and in a certain sense also the gas (which has ohmic conductivity) forming the dielectric. The phase lag is determined with the aid of a Braun tube provided with a Wehnelt (oxide) kathode; the Braun tube contains a condenser, and the kathode rays are deflected, the resulting Lissajous figure indicating the phase lag. The value of cos ϕ becomes smaller when the current intensity is raised, and greater, within limits, when the frequency is raised (50 to 560 ∿/sec.). The current efficiency can be expressed as a function of the ozone concentration; the constants of the formula are the current yield at ozone concentration zero and the max. ozone concentration obtainable under the conditions. But the character of the discharge is not independent of the ozone concentration. According to Cermak the brush discharge from a positive point contracts and shortens when the ozone percentage rises. Only the luminous discharge has an ozonising effect; the luminous zone is confined to the immediate neighbourhood of the kathode, but spreads from the anode with the width of the annular vessel (*i.e.*, distance between the electrodes). For high ozone concentrations the distance between the electrodes should be small, for high current-yields large. On the whole, apparatus with metal coatings are advisable for technical purposes when concentrations of 5 or 10 gm. of ozone per m.^{3} are wanted; for higher concentration glass apparatus (with acid coatings) are preferable. Working in atmospheric air 85, 81, 76 gm. of ozone were obtained per kw.-hour at ozone concentrations of (very small), 4, 10 gm./m.^{3}. H. B.

578. *Ozone Formation at Line-electrodes.* **F. Fischer** and **K. Bendixsohn.** (Zeitschr. Anorg. Chem. 61. 2. pp. 158–180, Feb. 1, 1909. I. Chem. Inst. d. Univ., Berlin, May, 1908.)—The authors describe further experiments on the electrolytic formation of ozone, using two differently shaped anodes (made of glass tubing and Pt-foil) which were kept stationary. The one anode was of the shape of a tuning-fork, the Pt-foil being fused into the glass along the two prongs of the fork, and then ground smooth with the surface of the glass; the other anode was spiral-shaped, the Pt-foil running along the axis of the tube. In this way "line-anodes" were obtained, the effective area of which was fairly large, so that high currents could be used, although the width of Pt-foil exposed to the electrolyte was very small. The results are as follows: The position of the electrode in the apparatus has a great effect on the yield of

ozone. Line-electrodes 0·01 mm. thick are satisfactory and admit of extended use, whereas if the width is only 0·005 mm. the thin foil is no longer homogeneous. If the current is continuously increased by raising the e.m.f., a point is reached at which the e.m.f. suddenly increases, and at the same time the yield of ozone decreases. This "change-over point" depends on the current density and on the density of the sulphuric acid electrolyte. The anode can thus have two potentials with one and the same current, the higher potential existing only between certain definite current strengths. This phenomenon, called by the authors the "anodic after-effect," is caused by a deposit of platinum sulphate on the anode. The yield of ozone alters continuously with the current density, but discontinuously with the concentration of the acid; it also increases as the width of the line-anode is diminished, the greatest yield being 21·6 per cent. by weight, the electrode not being cooled. Cooling the electrolyte has a marked effect with these stationary electrodes; the percentage of ozone was 15·5 at 12° C., while at —8·5° C. it was 27 per cent. A limit is placed on the amount of cooling to which the electrolyte can be submitted, and hence to the yield of ozone, by the "change-over point," the position of the latter falling almost proportionately to the temperature. The "change-over point" also occurs with rotating electrodes, but can only be detected when the electrolyte is cooled. The influence of temperature on the yield of ozone with rotating electrodes is very great. [See Abstract No. 855 (1909).] T. S. P.

579. *Electrolytic Alkali. Theory of the Bell-anode Process.* **A. Brochet.** (Comptes Rendus, 147. pp. 674–676, Oct. 19, 1908.)—The solution of chloride directed towards the anode becomes charged with free alkali which takes part in the electrolysis; the first OH′-ions form a boundary layer which moves towards the anode. If the velocity of flow of the electrolyte be equal or superior to the velocity of the OH′-ions, the efficiency will be theoretical. For the bell process (in which the anodes are enclosed in a bell), the author shows under reference to P. A. Guye that, when the boundary layer remains stationary, the equivalent concentration of the lye leaving the cell is directly proportional to the conductivity of the electrolyte, and inversely proportional to the mobility of the OH′, but independent of the current density and the nature of the alkali. It is, however, more profitable to decompose potassium than sodium chloride. The temperature influence on the efficiency is unimportant, since the diluted alkali lye and the concentrated chloride solution have practically the same temperature coefficient of 2 per cent.; with regard to the e.m.f. required, however, it will be advisable to work with a warm electrolyte. H. B.

580. *Electrolytic Processes at Electrode Surfaces. Supertension and Electrocapillarity.* **H. G. Möller.** (Ann. d. Physik, 27. 4. pp. 665–711, Nov. 26, 1908. Physikal. Inst. d. techn. Hochschule, Charlottenburg.)—The following conceptions of the electrolytic deposition of gases are put forward: The hydrions are discharged reversibly with the formation of H_2. The hydrogen at first remains dissolved in the electrode. It forms a layer, rich in gas and about 10^{-7} cm. thick, which is kept in equilibrium under the influence of the thermal partial pressures, the molecular attractive forces and the electrical forces. The electrical field is caused by the negative charge on the surface of the electrode and the positive charge on the ions distributed in the layer. By means of the above conceptions and with the aid of the mathematical methods of van der Waals and Bakker the author has calculated the spatial distribution of the electrolyte, the hydrogen, and the ions in the layer. From the mathematical conditions for the equilibrium it follows that: (1) the supertension increases with increasing angle of contact and with increasing surface tension of the electrolyte against air; (2) the maximum of the electrocapillary curve is always at the same point—*i.e.*, at the absolute potential zero—so long as the electrolyte contains a sufficient concentration of the ions of the metal forming the electrode. It is displaced in the direction of smaller polarisation with all electrodes which give complex salts on solution; this displacement is greater with solid electrodes than with mercury. The experiments are in complete accordance with the theory, as shown by the following: I. The capillary tension at the surface gas/electrolyte and the supertension run parallel, as was shown with Hg, Cu, and Ag for different temperatures. Both the capillary tension-temperature curve and the supertension-temperature curve show the same irregularities at about 6°. II. Contact angle and supertension run parallel (*a*) at different temperatures (tested on Hg); (*b*) on electrodes the surfaces of which have been greased to different extents; (*c*) on electrodes which have been polished to different degrees; (*d*) on electrodes with surfaces of different activities (tested on Ag); (*e*) on electrodes made of different metals. III. The position of the maximum of the electrocapillary curve is independent of the metal and the electrolyte so long as the latter contains ions of the metal. The greater the complexity of the electrolyte the more is the maximum displaced in the direction of smaller polarisation, as was shown with ammonium hydroxide and potassium cyanide. This displacement always occurs if the metals can form complex salts and it increases with the molecular forces of the metal, as was shown with Hg and Cu. The results show that the method of measuring the absolute potential of an electrode against an electrolyte by means of the capillary electrometer or by "drop electrodes" is quite trustworthy, and that the source of e.m.f. in a galvanic cell is in accordance with Nernst's theory [see Abstract No. 1016 (1908)]. T. S. P.

581. *Kathode Volatilisation by Canal Rays. Emission of Secondary Atom Rays.* **J. Stark.** (Zeitschr. Elektrochem. 14. pp. 752–756, Nov. 13, 1908.)—With reference to the controversy between V. Kohlschütter and F. Fischer and O. Hähnel [see Abstract No. 178 (1909) and next Abstract], the author points out that the kathode volatilisation of metals in rarefied gases cannot be purely thermal in Hittorf's sense, since the electrode as such does not become sufficiently warm. It is only those spots which are hit by canal rays (rapidly moving positive ions) which are raised to a high electric temperature. Canal rays are not all positively charged atoms in rapid motion, however. He suggested in 1908 that neutral atoms and molecules may assume ray character travelling in rectilinear paths and striking obstacles with sufficient energy to cause luminescence. A neutral atom-ray may be produced by the union of positively and negatively charged atoms; or when a positively charged atom strikes a neutral atom and imparts its energy to it without causing ionisation. A positively charged atom-ray, on the other hand, would result when a neutral atom loses a negative electron (or several) by collision, or by collision between a neutral atom-ray and an atom causing ionisation. The existence of neutral atom-rays has recently been supported by W. Wien and J. J. Thomson, and Füchtbauer, L. W. Austin, W. Hermann, and S. Kinoshita have independently found that canal rays are reflected by solids. These various canal rays are endowed with high kinetic energy; an atom of a solid or liquid struck by a canal ray may itself assume ray character, enter the gas space, be stopped in it and return to the electrode or settle on the wall. The temperature of the electrode as such would matter little; for the mean kinetic energy of a molecule is, up to absolute temperatures of about 1,000°, small compared to the kinetic energy of a canal ray. But the character of the gas and of the electrode, and also the pressure would be of influence. There would further be disturbing secondary influences. Thermal effects would come into play with metals of high vapour-pressures at low temperatures (alkali metals, Zn, Cd, Hg), and chemical combinations might also occur. Aluminium is little volatilised in oxygen, in which it becomes covered with a film of oxide. That film forms also in hydrogen in the presence of a little oxygen; when the film is reduced again, however, and in pure hydrogen, Al is volatilised, though less than other metals. This volatilisation of Al increases with increasing kathode potential-fall and with decreasing gas pressure; it is much more pronounced in the presence of mercury vapour than in pure hydrogen. [See also Abstract No. 119 (1909).] ✓

H. B.

582. *Chemical or Physical Theory of Kathode Volatilisation?* **F. Fischer** and **O. Hähnel**. (Zeitschr. Elektrochem. 14. pp. 677–681, Oct. 2, 1908. From the Chem. Inst. d. Univ., Berlin.)—Continuation of the controversy with Kohlschütter [see Abstract No. 178 (1909)]. The kathode volatilisation in gases is a purely physical vaporisation phenomenon. The authors have worked with weaker currents than Kohlschütter. They speak of kathode loads (Belastungen), but indicate only amps. and watts, though they mention J. Stark's kathode bombardment by positive ions of 1902. At low kathode loads the nature of the gas is immaterial, and the same weight of metal is volatilised in hydrogen and in argon. At higher kathode loads the cooling effect of the gas comes into play, and less metal is volatilised in hydrogen than in argon; this effect becomes more pronounced at increased gas pressure. The volatilisation is diminished by the formation of oxides or nitrides on the kathode, but there is no proof of the formation of argon compounds such as would justify a chemical theory. **V. Kohlschütter.** (Ibid. pp. 681–688, Oct. 2, 1908.)—Kohlschütter points out that his currents were not stronger than those of Fischer; the current curve, not the mean intensity, is the chief feature. Stark's views of 1902 have to be modified in accordance with the experiments of Holborn and Austin (1904) that different metals are volatilised in quantities corresponding to their chemical equivalents. **B. Walter.** (Ibid. p. 695, Oct. 9, 1908.)—The phenomena really depend, not on the quantity of electricity, but on the energy, the product of quantity by the fall of potential at the kathode, and this fall is smaller in argon than in hydrogen.

H. B.

583. *Use of Rotating Anode in Electrolytic Separations.* **M. E. Holmes.** (Amer. Chem. Soc., Journ. 30. pp. 1865–1874, Dec., 1908.)—The conditions of work were as follows: The current was kept in almost all cases below 1 amp. Currents below 0·3–0·4 amp. were not found useful. The rotating dish anode first used by Miss Langness [see Abstract No. 1,264 (1907)] was employed, the kathode being a Pt dish of 200 c.cm. capacity. The time required for a determination was from 45–60 min., and the electrolytes used were (1) sulphuric acid, (2) ammonium acetate and acetic acid. The constant-current method was used, the potential of the kathode not being measured [so that the results obtained will only hold for the particular apparatus used]. The results are as follows: Separations of Cd from Al and Mg are possible in all

cases studied. The best conditions for the separation of Cd from Cr were with a high current and phosphoric acid as electrolyte, although the separation is possible with a low current in sulphuric acid solution. The separation of Cd from Fe is possible with a high current, but not with a low current. Separations of Cd from Co and Zn are possible with a low current, but not with a high current. The separation of Cd from Ni is possible with both a high and a low current, but the first is to be preferred. The separation of Cd from Mn is best made with a high current, but may be made with a low current if formic acid is the electrolyte. [See Abstract No. 498 (1905).] T. S. P.

584. *Electrolytic Estimation of Lead and Manganese using the Filtering Crucible.* **F. A. Gooch** and **F. B. Beyer.** (Amer. Journ. Sci. 27. pp. 59–64, Jan., 1909. Contribution from the Kent Chem. Lab., Yale Univ.)—The authors have continued their work on the use of a filtering crucible in rapid electro-analysis [see Abstract No. 872 (1908)], and have obtained satisfactory results in the estimation of Pb and Mn as peroxides. The time necessary for the deposition of approx. 0·15 gm. PbO_2 was about 2 hours, using a current density of 5–10 amps./dm.² and 4–5 volts. 0·19 gm. MnO_2 was deposited in from 2–8 hours, using a current density of 5 amps./dm.² and 20–10 volts. The processes are obviously inferior in point of convenience to the more rapid processes which demand the use of large and special Pt containers and motors, but in the absence of such apparatus they may serve a useful purpose. T. S. P.

REFERENCES.

585. *Atomic Weights of Nitrogen and Silver.* **T. W. Richards, P. Köthner,** and **E. Tiede.** (Amer. Chem. Soc., Journ. 31. pp. 6–20, Jan., 1909.)—From determinations of the ratio silver chloride : ammonium chloride, the latter material being very carefully purified, the following atomic weights are arrived at, on the basis of O=16 and H=1·0076 : Ag=107·881, Cl=35·457, and N=14·008. T. H. P.

586. *Hardness and Electric Resistance.* **C. Benedicks.** (Zeitschr. Anorg. Chem. 61. 2. pp. 181–186, Feb. 1, 1909. From the Chem. Laborat. d. Univ., Upsala, Nov., 1908.)—Remarks upon the paper dealt with in Abstract No. 307 (1909). The law relating electrical resistance and concentration of a body in solid solution in a metal is a straight line, but conductivity, its reciprocal, is a hyperbola. The conductivity is commonly more convenient for metallic aggregates, and resistance for solid solutions. F. R.

587. *Atmospheric Nitrogen in the Production of Calcium Cyanamide.* **A. R. Frank.** (Faraday Soc., Trans. 4. pp. 99–114 ; Discussion, pp. 114–119, Oct., 1908.)

588. *Heats of Combustion of Aluminium, Calcium, and Magnesium.* **F. E. Weston** and **H. R. Ellis.** (Faraday Soc., Trans. 4. pp. 130–133, Oct., 1908.)

589. *Thermo-chemistry of Phosphorus.* **J. C. Thomlinson.** (Chem. News, 99. p. 40, Jan. 22, 1909.)—The author has shown previously that phosphorus behaving as a quadrivalent element should have a heat of combination 32·025 cals., and oxygen as a monovalent element 71·228 cals., and when divalent 52·545 cals. From these values the author deduces numbers for the heats of combustion of the various modifications of phosphorus in good agreement with the experimental values. T. H. P.